No. 2622 VOLUME 75 FRIDAY 24 APRIL 1959

FLIGHT

AIRCRAFT, SPACECRAFT, MISSILES

Official Organ of the Royal Aero Club First Aeronautical Weekly in the World Founded 1909

Editor-in-Chief
MAURICE A. SMITH D.F.C.

Editor
H. F. KING M.B.E.

Technical Editor
W. T. GUNSTON

Production Editor
ROY CASEY

IN THIS ISSUE

Giving and Receiving 564
U.S. Missile Tour 565
Aero Engine Development 568
Air Transport and its Future 569
Financing the Jets 571
The Aircraft Industry —a National Asset 572
Cameras in Evidence 576
Lightweight Inertial-navigation System 591

Iliffe & Sons Ltd., Dorset House, Stamford Street, London, S.E.1; telephone Waterloo 3333. Telegrams Flightpres Sedist London. Annual subscriptions: Home £4 15s, Overseas £5. Canada and U.S.A. $15.00. Second Class Mail privileges authorized at New York, N.Y.

Branch Offices Coventry: 8-10 Corporation Street; telephone Coventry 25210. Birmingham: King Edward House, New Street, 2; telephone Midland 7191. Manchester: 260 Deansgate, 3; telephone Blackfriars 4412 or Deansgate 3595. Glasgow: 26B Renfield Street, C.2; telephone Central 1265. New York, N.Y.: Thomas Skinner & Co. (Publishers) Ltd., 111 Broadway, 6; telephone Digby 9-1197.

© Iliffe & Sons Ltd., 1959. Permission to reproduce illustrations and letterpress can be granted only under written agreement. Brief extracts or comments may be made with due acknowledgement.

The Fateful Days

WHEN the Duke of Edinburgh congratulated us on our Golden Jubilee he alluded to the remarkable growth of aviation and added, "I am convinced that *Flight* will have things just as remarkable to report in the next fifty years." We braced ourselves for the job of chronicling all the ventures and vicissitudes of times to come. It was not so much the extent of progress that caused us some concern, for that we recognized as limitless. It was the sheer relentless pace and the immensity of decisions that must make it all possible. How headlong the pace and how grave the decisions, events and utterances of even one week have shown.

Our own industry has received the double impact of a formal recommendation that work should begin forthwith on two types of supersonic airliner, and of portentous declarations bearing on its future, made by some of its leaders at Southampton (pages 572-575). Official details have been released of a truly revolutionary aerial vehicle (page 562), and the R.A.F. has fired its first IRBM. America's contribution has been a controllable Earth satellite and an air show to outdo them all (except perhaps the approaching Paris Salon); and Russia has weighed in with more world records with her mighty Mi-6.

Never, to us in Britain, has the press of events seemed so demanding; nor have our past and our future appeared to us so challenging. Daily we see more clearly that our place in aviation will be our place in the world. Worries and vexations will continue to beset us. But if heed is paid to the wisdom spoken at Southampton last week, and recorded in this issue, we shall not go under.

Vive la France

FRENCH aircraft constructors were once inclined to produce startling and ingenious prototypes of which little more was subsequently heard; but two years or so ago the situation changed radically. An export drive was launched. The world began to take an interest in the unique and excellent aeroplanes France had to offer; production lines began to hum; next-generation prototypes emerged.

Then came the country's series of economic crises, and it seemed that government orders would be cut drastically and the industry virtually extinguished. Yet —and as we showed by a summary of French orders in *Flight* for February 27— the situation was by no means as bad as it appeared. Now further reassurance is forthcoming from a 2,000-mile tour of France which a staff member has just made in our Gemini in order to study the situation at first hand and gather advance news of what may be displayed at Le Bourget in June.

The tremendous concerted effort to produce and sell the Caravelle is reported on p. 586 and the first picture of the Dassault Mirage IV Mach 2 twin-jet attack-bomber appears overleaf. The new Sud 3200 and Alouette III helicopters were illustrated last week. First flights of the 3200, Super Broussard, Communauté and Mirage IV are imminent, and the astonishing Coléoptère will soon attempt translation. The Bréguet 940, at a gross weight of 14,300 lb, has already reached 50ft, from rest, in zero wind, in 216 yd. A dozen civil and military types are in quantity production. Three French aircraft have flown at around Mach 2. Turboméca are establishing a commanding production lead with small gas turbines.

Such are some of the highlights of the current revival. The industry may have been "rationalized," but there is plenty of intelligently directed effort and sound commercial sense; and French genius remains undimmed.

FROM ALL QUARTERS

Britain's Space Programme

THE following statement was made by the Minister of Supply, Mr. Aubrey Jones, in the House of Commons on April 20, in answer to Members' questions:

"The United Kingdom missile programme could, with some adaptation, give an initial launcher in aid of a space research programme, but of itself could provide neither the satellites nor the instruments needed to attack the important scientific problems involved in space research. The Government are at present considering the question of a British space research project using earth satellites in the light of advice from the Advisory Council on Scientific Policy [whose report was submitted last month—Ed.]. A statement will be made as soon as possible. The Government have in mind the scope which such a project would provide for co-operation with appropriate Commonwealth countries, but discussions can most profitably take place when the scale and nature of any British effort have been decided on."

The Avrocar

FOR at least six years rumours have been rife concerning the "saucer" known to be under development by Avro Aircraft at Malton, Ontario. In 1955 it was stated that this programme had been purchased outright by the U.S.A.F. as Weapon System 606A; last week the Space Committee of the House of Representatives in Washington was given a classified briefing on the project, which now appears to be managed by the U.S. Army and Air Force jointly.

Brig. Gen. Frank Britton, Army Director of R. and D., stated that the vehicle was known as the Avrocar, made use of "the ground-cushion phenomena" [*sic*] involving extremely high-pressure jets at the sides and underside of the vehicle, had hovering capability combined with high performance, and appeared to offer "a great potential to the United States Army for increasing its mobility in the combat area." Further testimony by Mr. J. B. Macauley, deputy director of research and engineering, Department of Defense, stated that his department had spent $5.5m on the project under contract with Avro Aircraft since 1955. It is reported that the testimony mentioned a maximum speed of 300 m.p.h. and a range of 1,000 miles.

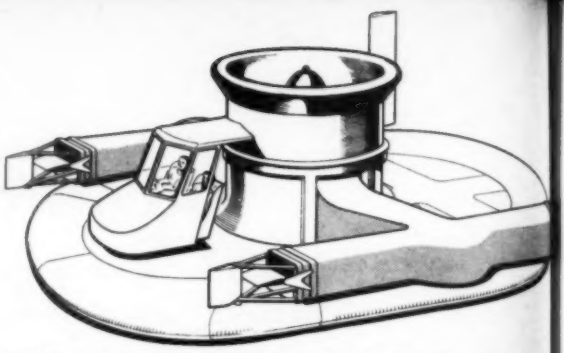
Hawker Board Strengthened

IN line with the recent consolidation of Hawker Siddeley aviation interests under Hawker Siddeley Aviation Ltd., and subsequent reorganization within the operating companies, the following appointments are announced at Hawker Aircraft Ltd., Kingston-on-Thames: J. T. Lidbury, appointed managing director; J. A. R. Kay, director; Sir Sydney Camm, director and chief engineer; S. D. Davies, director; R. H. Chaplin, executive director and chief designer; and E. G. Rubython, executive director.

The Hovercraft

SPONSORS of the revolutionary Hovercraft being constructed by Saunders-Roe Ltd., the National Research Development Corporation have decided to release preliminary details in order to stem the flood of inaccurate reports about this project. They state:—

"The prototype of the Hovercraft, which is supported on a 'cushion' of air and skims across the surface of the sea, is due to commence its operational trials during the next few weeks. The first operational craft will probably weigh less than 100 tons; but the efficiency of the Hovercraft increases with its size, and experiments carried out in the Isle of Wight show that craft weighing thousands of tons and travelling at speeds of about 100 kt are possible. An important feature of the Hovercraft is that it can be loaded and serviced on land, making harbours and expensive port facilities unnecessary. This means that it could operate in many parts of the world at present inaccessible to modern transport.



SKIMMER: This artist's impression of the SR. N.1 Hovercraft (see below) has been issued by the N.R.D.C. The ducted fan is within the central pylon, from which emerge T-shaped propulsion ducts with control surfaces at their extremities

"The principle was invented by Mr. C. S. Cockerell, who started work on the project in 1953. His experiments proved the possibility of supporting a craft on a cushion of air. Tests with models showed that it was feasible to build a full-sized craft and that, by bleeding off some of the air to suitable nozzles, it could be propelled and controlled horizontally. It was decided to build a man-carrying experimental craft, and the N.R.D.C., through its subsidiary, Hovercraft Development Ltd., placed a contract with Saunders-Roe Ltd. to undertake the research, design and development of such a craft.

"The first Hovercraft made by Saunders-Roe has been designated the SR. N.1. It is 30ft long and 24ft wide and is powered by a 450 h.p. Alvis Leonides Mk 70 which drives a ducted fan to provide the supply of air for lift and propulsion. It has a crew of two and will be "flown" by Peter Lamb, Saunders-Roe test pilot. The N.1 is nearing completion and its first tethered trials will take place during June. These will be followed by free trials on the Solent."

Supplementing this information is a statement by The Airscrew Company & Jicwood Ltd., who have designed and built the fan blades which provide the lifting force and enable the Hovercraft "to ride at anything from 3ft to 7ft above the surface of the water." The four fan blades are constructed from resin-bonded mahogany laminations, covered with a special plastic material and with metal-sheathed leading edges. The company also supply the pre-rotational vanes of resin-bonded birch veneers, which are built into the intake nose fairing. The tips of these vanes are dowled and bonded to a section of double-skinned birch-ply ducting. The entire assembly is finished with aluminium bituminous paint.

Royal President

IT was announced last week that the Duke of Edinburgh had consented to become president of the College of Aeronautical and Automobile Engineering, Chelsea, for one year from November 1959. He succeeds Lord Brabazon of Tara, who is retiring after having been president since 1950. There are more than 500 students, from about fifty countries, at the College.

Corridor Politics

A THIRD high altitude flight along one of the air corridors into Berlin was made on Wednesday last week (April 15) by a C-130 Hercules of the U.S.A.F. As on a former occasion [*Flight*, April 10] the aircraft was "buzzed" by Soviet fighters, and the U.S.A. and the U.S.S.R. exchanged protests, the former about the buzzing and the latter about the altitude. The American embassy in Bonn said on April 16 that the C-130, which was flying at about 20,000ft, had been "severely harassed" by Mig aircraft and that the latter had "performed dangerous manœuvres."

MIRAGE IV, Dassault's new Mach 2 bomber prototype, with two SNECMA Atar 9 turbojets, bears a most striking resemblance to the Mirage III intercepter, except for its bogie undercarriage. It is a two-seater

NAVY AND ARMY requirements are respectively met by the turbine-powered Saunders-Roe P.531 general-purpose helicopter, seen above in its new naval uniform, and by the Westland Westminster (right). The Westminster is seen lifting a section of an assault floating bridge weighing 6,736 lb. "Slim" Sear conducted the laden helicopter to "an imaginary destination"

"Flying Stations" in the City

THE call "Flying Stations" was sounded at the Grocers' Hall, in the City of London, at a Livery Dinner of the Worshipful Company of Coachmakers and Coach Harness Makers of London on April 14. The instrument was a sterling silver bugle presented to the aircraft carrier H.M.S. *Centaur* (Capt. Horace Law, R.N.) by the Company, which has "adopted" the vessel. Earlier, the Company had presented *Centaur* with a drum major's outfit.

As always, the aircraft industry was prominentaly represented at the dinner, which was attended by the French, American and Portuguese ambassadors and their ladies. Then Hon. Denis Berry (Senior Warden) proposed "The Lord Mayor and the Corporation of London and the Sheriffs," and the Lord Mayor replied. Bishop H. A. Wilson proposed "The Worshipful Company of Coachmakers and Coach Harness Makers, Root and Branch 'May it Continue and Flourish for Ever'," and the Master (Mr. R. J. D. Smith) responded. It was during his response that he called on Bugler Burns to sound off "Flying Stations." Mr. Roland E. Dangerfield (Past Master) proposed "The Guests"; and in the absence of Lord Justice Ormerod, Col. A. E. Young, Commissioner of Police of the City of London, replied.

Bristol Siddeley Test Pilot

CHIEF test pilot of Armstrong Siddeley Motors Ltd. since 1955, F/L. T. P. Frost is the first chief test pilot of Bristol Siddeley Engines Ltd. Tom Frost, who is 36, joined the R.A.F. as a Halton apprentice. After three years' training, he went to the Middle East in 1941 as an engine fitter, then in 1944 took a pilot's course in Rhodesia, subsequently flying Lancasters with No. 149 Sqn. Later, he went to C.F.S., qualifying as an A.1 instructor. An E.T.P.S. course was followed by experimental test-flying on Valiants, Vulcans, Javelins and Hunters at Boscombe Down. In his new post Frost will be responsible for flight-testing Bristol Siddeley engines (including the Olympus, Orpheus, Proteus, Viper, Double Mamba, Sapphire, P. 181 and P. 182) at Filton and Bitteswell.

F/L. Frost

Brough Subsidiaries

THREE operating subsidiaries have been set up by Blackburn and General Aircraft Ltd., which now becomes a holding company. They are Blackburn Aircraft Ltd., Blackburn Engines Ltd. and Blackburn Electronics Ltd. The Board of the aircraft company is as follows: Mr. E. Turner (chairman and managing director), Mr. N. E. Rowe, Mr. T. Bancroft, Capt. E. D. G. Lewin, R.N., Mr. B. P. Laight and Mr. R. H. Stone (secretary). Mr. Laight is chief designer (aircraft) and Mr. Stone company secretary of Blackburn and General Aircraft Ltd. The engine company Board consists of Messrs. Turner, Rowe, Bancroft and Stone, Capt. Lewin and Mr. J. B. Bucher (general manager) and G/C. H. J. Wilson. Mr. Bucher is general manager of the engine division and G/C. Wilson sales manager. The directors of the electronics company are Mr. A. F. Jopling (chairman), Capt. Lewin, Messrs Rowe, Bancroft and Stone and Dr. F. Fuchs (general manager) and Mr. E. G. Seath. Dr. Fuchs is manager of the commercial electronics department and Mr. Seath is chief engineer at Blackburn (Dumbarton) Ltd.

Each of the subsidiary companies will be fully represented on the Board of Blackburn and General Aircraft Ltd., from which (it is also announced) A.V-M. H. N. Thornton has retired.

"Zura" Honoured

AWARDED annually for the most outstanding contribution to Canadian aviation, the McKee Trophy for 1958 has gone to Janusz Zurakowski, formerly chief experimental pilot of Avro Canada Ltd., and now a staff engineer in the company's technical design department.

IN BRIEF

The Discoverer II satellite was released on its 17th orbit and at the time of going to press is thought to have landed in Spitzbergen. A U.S.A.F. team is searching on that island.

* * *

The Allison T63 (Model 250) turboshaft engine of 250 h.p. was run for the first time on April 1.

* * *

What are claimed as new world weight-to-height records for helicopters were set up on April 16 by Soviet pilots flying MI-6s. On one flight, five tons of cargo was lifted to an altitude of 5,550 metres (approximately 17,300ft); and on another, ten tons was raised to 4,600 metres (approximately 15,180ft).

* * *

At a Welwyn Garden City inquest last Friday on Mr. W. L. M. O'Connor, who was killed in an accident to a Miles Gemini at Panshanger airfield on March 4, a verdict of death by misadventure was recorded. Expert witnesses blamed metal fatigue in the crankshaft for causing one of the propellers to break away in the air.

BLACKBURN DIRECTORS (see above) include, l. to r., Messrs. Turner, Rowe and Bancroft; Captain Lewin; and Messrs. Laight and Jopling

W/C. Beetham's Valiant, XD861, refuelling from the tanker Valiant flown by S/L. J. H. Garstin (XD870): a photograph taken at 40,000ft over the Sahara by an Air Ministry photographer through the frosted canopy (outside air temperature —50 deg C.) of a Canberra of No. 58 Sqn. flown by F/L. P. Major. Contact was made at the first attempt

GIVING AND RECEIVING

R.A.F. Air-to-air Refuelling Techniques

IN the early hours of April 16 two Vickers Valiants of No. 214 Squadron, Bomber Command, made contact high above the North African coast near Tripoli. They flew eastwards on a common track to a rendezvous point at Misurata, then turned southwards. On this course they began a refuelling operation which lasted roughly a quarter of an hour. Then the tanker aircraft returned to Idris, whence it had come, and the replenished receiver flew on to Salisbury in Southern Rhodesia.

This Valiant (XD861, captained by the squadron commander, W/C. M. J. Beetham) had taken off from No. 214's base at Marham in Norfolk at 0230 hr G.M.T. It passed a timing-point at Salisbury at 1242 hr, having thus flown 5,319 statute miles in 10 hr 12 min, giving an average speed of 521.4 m.p.h. This was the first non-stop flight from the U.K. to Southern Rhodesia, and as such a considerable feather in the squadron's cap.

Not that No. 214 is unused to such honours. Nine days previously one of its Valiants had set up an unofficial record by flying from Marham to Nairobi (4,350 miles) in 7 hr 40 min, representing an average speed of 567 m.p.h. For that flight, the aircraft concerned was also refuelled by another of the squadron's Valiants, based temporarily at Luqa; and from No. 214's point of view the success of such a journey is measured more by the efficiency of the refuelling than by any records which may be achieved.

Thus, though last week's flight by W/C. Beetham was something of a pioneer journey, of more interest to his feelings as squadron commander would be his successful rendezvous with, and subsequent refuelling from, the tanker Valiant on the way out, and the double refuelling on the way back, by aircraft coming up from Nairobi and Idris. (This return flight was accomplished last Monday, the Valiant flying 5,555 st. miles, in head winds, in 11 hr exactly—an average speed of 505 m.p.h.)

When W/C. Beetham landed at Salisbury he is reported to have said that everything had gone smoothly, adding: "The purpose of these flights, which will continue to increase in range, is to perfect operating procedures, especially rendezvous techniques and signals communications." This underlined what he had said at Marham some 24 hours previously, when Air Ministry invited the Press to hear about the work being done by the R.A.F. on air-to-air refuelling. He stressed then that the two most important things on such flights were accurate navigation and signals communications. What emerged, too, was the amount of versatility and team-work required and how No. 214 have achieved an efficient synthesis of the various factors involved; their aircraft, in both the giving and receiving rôles; the relevant crew techniques; and the equipment developed by Flight Refuelling Ltd.

A.V-M. K. B. B. Cross, A.O.C. No. 3 Group and C-in-C.-designate of Bomber Command, explained that air-refuelling trials which the squadron had been conducting were now complete and that the equipment was working "very satisfactorily." No. 214 were training to do air refuelling in any part of the world; it would be a requirement for fighter aircraft such as the Lightning, though at the moment its use was confined to Bomber Command. At present No. 214 had the dual function of being both a bomber and a tanker squadron.

W/C. Beetham said that his squadron had been testing the Valiant both in the tanker and receiver rôle, and all crews were trained in either capacity. Recently it had carried out a series of non-stop flights to Nairobi, with 7 hr 40 min (as already mentioned) as the fastest time achieved. From W/C. Beetham's remarks and from an excellent film that was subsequently shown, it was possible to gain a good idea of what is involved in planning a long-distance flight with refuelling, and in the actual procedure.

Describing the Salisbury operation, he said that two tanker aircraft were positioned at Idris for the outward journey; there were also two Valiants ready at Marham, a primary receiver and a reserve aircraft. The operation was geared up to readiness 24 hr ahead. Signals were sent to Salisbury and Idris, stating the amount of fuel required and the aircraft callsign, and a reply would then come from the tanker aircraft agreeing to the operation.

There was to be a weather check three hours before take-off then confirmatory signals would be sent. According to the met. winds received and the consequent flight-plan, the time of take-off might be adjusted. With a planned take-off time of 0200 hr (subsequently revised) the rendezvous time with the aircraft from Idris would be 0526, the tanker Valiant having taken off from there at 0439. (Its take-off time is crucial in a hot climate, both from the point of view of aircraft performance and because the longer a tanker has to fly, the less fuel it can give.) The two aircraft would have a "common point" overhead Idris, and fly on a common track (with a separation height of 1,000ft) to their rendezvous at Misurata. At their first meeting, they might see each other at a distance of 80 miles, if the contrails were good enough. By the time they reached the rendezvous point the tanker would have trailed his 90ft length of refuelling hose. Refuelling is controlled in the tanker by the radar navigator, and the receiver is hooked up for 10-15 minutes.

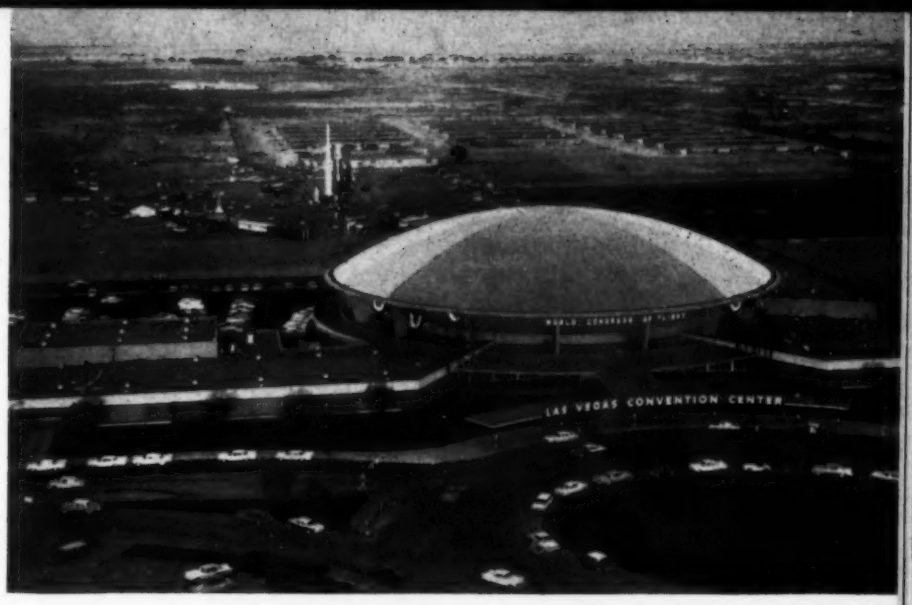
The film shown had been made by No. 214 Sqn. last year and it depicted brilliantly how a flight refuelling operation is carried out, dwelling on and illustrating what not to do as much as what to do, for the benefit of crews under training. (A missed contact is marked by some fish-like meanderings, and a good one by a satisfying "clunk.") The tanker must be flown at a smooth attitude and speed, the receiver must position astern and slightly below, at a closing speed not in excess of 5 kt. The pilot should then aim to fly up the line of the hose. When the 8ft-long probe has entered the drogue (which has a diameter of 31in) and opened the fuel valve it "pushes back" some 30ft of hose on to the drum until an ideal refuelling position, marked by a yellow band, has been reached. The pilot watches the tanker to keep his position steady and for his guidance there are red, yellow and green "traffic lights" in the tanker aircraft's bomb-bay. When he gets a red, he must break off refuelling contact; green means that the main fuel line is open; the lights go to amber when the allotted fuel has been received. These lights also enable the operation to be carried out in radio silence.

A captain of aircraft can develop his refuelling technique only by flying practice. Sometimes it may take him 20 minutes or more to make his first contact. As far as the radar navigator in the tanker, and the co-pilot in the receiver, are concerned their parts can be simulated; and at Marham there are simulators (made by Miles Electronics Ltd.) on which not only basic procedures but every kind of emergency can be practised. The cockpit layouts for the co-pilot in the receiver aircraft (who controls the intake of fuel and its disposition) include representations of each type of V-bomber. So far, however, Bomber Command refuelling has been confined to Valiant-to-Valiant operations and No. 214 Sqn. has done some most important and useful work.

CANBERRA NOSE FOR THE NATION

THE complete nose section of the Canberra which made the first double Atlantic crossing in one day—on August 26, 1952—is being preserved as an exhibit in the Science Museum in London. At an informal ceremony on Wednesday of last week the nose section, which has been restored to its original paint and equipment layout, was handed over by Viscount Caldecote, deputy managing director of English Electric Aviation Ltd., to Dr. T. C. S. Morrison-Scott, director of the Science Museum. It will be on exhibition next to the Vickers Vimy which made the first non-stop Atlantic crossing in 1919.

The double Atlantic crossing was made by W/C. R. P. Beamont, with F/L. P. Hillwood as pilot for the return flight and S/L. D. A. Watson as navigator. The total duration of the flights was 10hr 3½min, during which 4,145 miles were covered at an average speed of 412 m.p.h. The flights were made between Aldergrove and Gander and the actual aircraft was the prototype of the Canberra B.5 which did not enter service.



Kenneth Owen secured this picture of the Las Vegas Convention Center from a Bell 47G; in the rear is the static park

U.S. Missile Tour

2—AIRCRAFT, MISSILES AND SATELLITES IN FABULOUS LAS VEGAS

FROM KENNETH OWEN OF "FLIGHT," Vandenberg A.F.B., April 16

THE privilege of watching the launch of Discoverer 2 here at Vandenberg, California, and the experience of visiting the World Congress of Flight at Las Vegas, Nevada, were the main features of the second phase of the British Press tour organized by the U.S. Air Force. Today a third important occasion was marked—the first launch of a Thor IRBM by a Royal Air Force crew (see p. 579-580).

By any standard Las Vegas is a remarkable place. When "the most comprehensive aerospace program ever presented" is added to the town's basic industries of gambling and entertainment the result is a unique mixture. One thing is certain—Farnborough was never like this.

The aims of the World Congress of Flight were nothing if not ambitious. "It will bring together," we had been told, "all elements of flight—designers, producers, operators, administrators and users. It will unite them in a common cause: the advancement of aeronautics and astronautics—the twin sciences of flight."

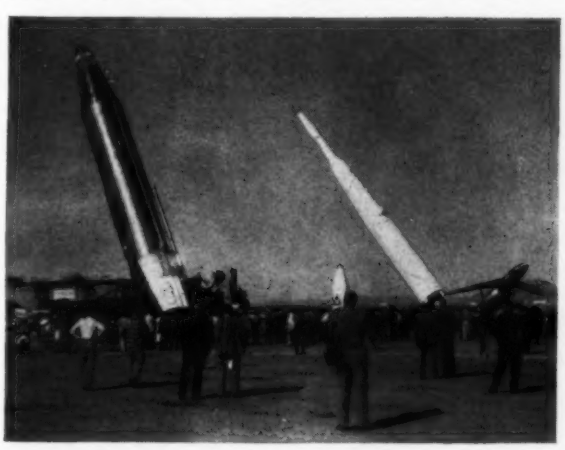
And this was not all. "The symposiums and conferences will explore flight in terms of international security and human welfare; analyse the social, economic, political and moral problems which accompany the progress of flight; present flight in its broadest concept as an instrument for the benefit of all mankind. The project is dedicated to the belief that greater world knowledge of aircraft, missiles and spacecraft—in realistic perspective—will help bring the world closer to permanent peace."

On to a basic pattern—air displays, static aircraft and missile park, and exhibition hall—similar to that of the S.B.A.C. Exhibition the organizers had grafted a heavy programme of meetings, symposiums and conferences. The main sponsor of the Congress was the Air Force Association, in co-operation with the Air Transport Association of America, Electronic Industries Association, Flight Safety Foundation, National Aeronautic Association, National Business Aircraft Association and the Space Education Foundation.

The week's programme included a jet-age conference (sponsored by the A.F.A.) and a space-age conference (S.E.F.); symposiums on the efficient use of airspace (National Pilots Association), aircraft and space communications (E.I.A.), international research (Air Research and Development Command, U.S.A.F.), aerospace education (S.E.F.), flight safety (Flight Safety Foundation), VTOL and STOL aircraft and turbine transport (Society of Experimental Test Pilots), advanced air traffic control concepts (N.B.A.A.), advanced air navigational aids and systems (N.B.A.A.), safety for private pilots (National Association of State Aviation Officials and F.S.F.) and a missile management conference sponsored by the Air Force Association.

These main meetings were to be accompanied by 87 presentations or briefings by 47 companies on specialized subjects ranging from *Re-usable Shipping Containers and In-process Product Protection* and *Airport Sweeping for the Jet Age* to *How Small Company Sells $250,000 Aircraft Radio by Direct Mail, Skinning Pounds off Missiles by Precision Abrasive Belt Machining*, and *Fanciful Flight to Wonderful Mexico*. The Congress was to run from Monday, April 13 to Sunday, April 19, with the general public admitted on the final two days.

Sunday, April 12, the Press preview day allowed us our first glimpse of the exhibits at the Congress. The main location was



The unconventional lifting tackle used to elevate the Atlas and Thor-Able is seen in action above, right

"FLIGHT" PHOTOGRAPHS

Left, the doorway in the Atlas, which did not form part of the original Weapon System 107

Right, another shot from the Bell, showing Thor-Able, Atlas, X-15, Snark, Bomarc and the Mercury capsule

U.S. Air Force line-up at Las Vegas (F-104A in foreground) and a close-up showing one of an F-102's six GAR-2A Falcon missiles

U.S. MISSILE TOUR . . .

Las Vegas' new convention centre, just completed at a cost of six million dollars. The building squats like a grounded flying saucer not far from the hotels fringing the famous Strip (or Los Angeles highway), and inside the centre the last few dollars of the six million were being spent as the final pieces of lush carpeting were tacked in place at the entrance to the vast circular auditorium. In the exhibition hall, too, the atmosphere was reminiscent of Farnborough, as public-relations men and display organizations rushed to complete the company stands and exhibits.

Only four exhibitors from abroad were included in the total of over 200—Rolls-Royce, Canadair, Lucas-Rotax and Marcel Dassault. Attendance at the congress, however, was said to comprise visitors from 47 countries.

In the static aircraft and missile park behind the centre, an Atlas and a Thor-Able, or reasonable facsimiles thereof, were the subject of a somewhat peculiar ceremony by way of a pre-opening opening to the congress. Buttons were pressed by the commander of the U.S.A.F. 1st Missile Division and by the president of the Air Force Association, some non-standard raising equipment was brought into use, and the two vehicles rose slowly together from the horizontal to the vertical position. "There they are, ladies and gentlemen of the Press," the loudspeakers vibrated with enthusiasm, "the Free World's two major missiles. The Atlas ICBM and the Thor IRBM. *You are invited to be among the first people to enter a ballistic missile.* We think you will find it interesting."

Which indeed we did. The invitation referred to Atlas 14A, retired from service after a number of static test firings and now seen to sport a couple of doors in its lower skin. Inside was a display of colour photographs of the missile. This display Atlas, we were told, was to go on tour throughout the U.S.A. and would be shown at this year's Paris Aero Show. The Thor-Able had been built from rejected parts and presented to the U.S.A.F. by Douglas Aircraft for public showing.

Other missiles on display included Mace, Bomarc and Snark and there were models of a Discoverer satellite and the Project Mercury capsule. Close to a full-size wooden mock-up of the North American X-15 was an incongruous trio—a Sopwith Camel, 1910 Blériot and Pfalz D.XII, all restored to flying condition by Tallman Aviation. Frank Tallman and his senior pilot Nelson Lomis were present in R.F.C. and German Air Service uniforms, as the photograph shows.

Around the sides of the missile park were the many-coloured sport and business aircraft and helicopters. Among the helicopters were Army and civilian versions of the Hughes 269A; a Djinn; and an Alouette carrying four SS.11 missiles. The light aircraft included, in addition to the products of the Beech-Cessna-Piper big three, lesser-known types such as the Morrisey 2150, Bellanca 260 and the agricultural AG-2.

The larger aircraft were on show at McCarran Field, the Las Vegas airport. Civil transports there included the Douglas DC-8, Convair 880, Lockheed Electra and Fairchild F-27 (a Boeing 707 of American Airlines made a brief appearance the following day), and the century-series line-up of fighters showed examples of the F-100D, F-101A, F-102A, F-104A, F-105B and F-106A. Considerable interest was displayed in the Avro Vulcan B.1s from No. 617 Sqn., R.A.F., while Vulcan crew members displayed an even greater interest in the Golden Jet girls of Continental Airlines. A Transport Command Comet 2 was also on show.

Among the week's flying events the noisiest and most exciting was to be the firepower demonstration at Indian Springs (45 miles west of Las Vegas) scheduled for Wednesday, April 15, and a rehearsal for this took place on the day of the Press preview. The fully packed programme included aerobatics by Italian, Dutch, Chinese and U.S. (Blue Angels and Thunderbirds) aerobatic teams; rocketry, gunnery, LABS and napalm demonstrations by F-100s; Sidewinders fired by F-100 at Radop towed target; aerobatic and attack demonstrations by F-101s, F-102s and F-104s; LABS display by F-105; KB-50 air refuelling exercise; simulated explosion of nuclear bomb dropped by a B-52; and formation flypasts by B-52s and the R.A.F. Vulcans.

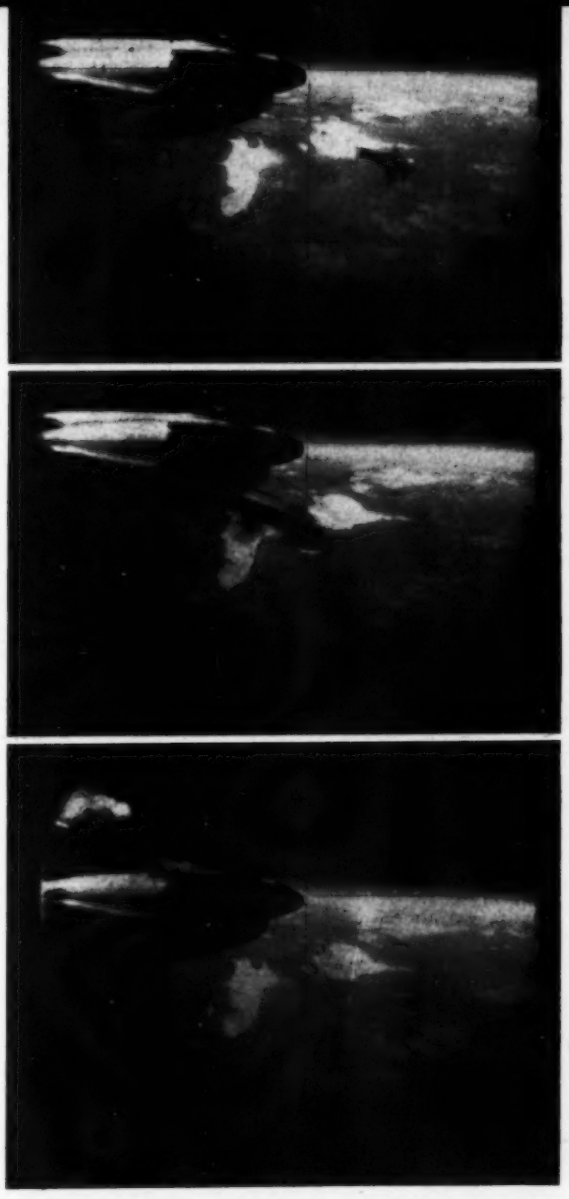
(*Continued on page 579*)

Left, Frank Tallman in R.F.C. "maternity jacket" with his chief pilot, Nelson Lomis (the Hun), in front of the D.XII

"FLIGHT" PHOTOGRAPHS

Below, the DC-8 and the Smith Miniplane (75 h.p. Continental) built by Paul Wright

Below, right, 617 meet the Golden Jet Girls; from left, Devona Hubka, F/L. G. Mullinger, Carolyn McGirr, F/O. C. V. Burkard, Betty Flood, F/O R. H. Wood



In a paragraph below we announce that the "more advanced surface-to-air missile" to be ordered for R.A.F. Fighter Command will be a development of the Bristol/Ferranti Bloodhound. These three frames were taken from a ciné film secured by one of the tip-mounted cameras carried by a Meteor U.15 target destroyed by a Bloodhound at Woomera. In the third picture the fuselage can be seen disintegrating. All prints are completely unretouched

Missiles and Spaceflight

BLOODHOUND DEVELOPMENT

Although the recently published Air Estimates contain only the cryptic announcement that "a new high-performance surface-to-air missile" is to be ordered for R.A.F. Fighter Command, it can now be stated that this weapon will be a development of the Bristol/Ferranti Bloodhound which is already in service. It is highly significant that a decision has already been taken to order a "stretched" version of the Bloodhound, and it facilitates the establishment of a single integrated weapon system capable of progressive extension and improvement to counter all likely threats as the latter develop. One of the many advantages of such a policy is that it permits fully-trained Bloodhound specialists to remain at missile stations over a long period without repeated re-training in new systems.

Some indication has been given by Bristol Aircraft of the improvements offered by the advanced weapon. "It will," say the company, "have a substantially increased operating range and altitude. Advanced techniques will also ensure still greater lethality at these increased ranges and heights, and will also improve low-altitude performance to counteract the threat of low-flying targets. This developed Bloodhound is merely the second step in the creation of the family; as the threat grows or changes, so will Bloodhound . . . be continuously improved to meet it." We publish on this page three frames from a ciné film showing a recent strike by a first-generation Bloodhound at the Weapons Research Establishment at Woomera.

BLUE STREAK PROGRESS

It has been reported by newspapers in Britain and Australia that the de Havilland Propellers Blue Streak long-range ballistic missile will be fired over the full 1,250 miles of the extended Woomera range early next year. According to the Associated Press, the weapon has an operational range of 2,200 miles and will be fired to a height of 1,000 miles (considerably higher than the apogee of a normal ballistic trajectory for this range) from Woomera to a 30-mile-radius target area at Talgarno, between Broome and Port Hedland, Western Australia. It has also been stated that static firings of the Rolls-Royce rocket engine which will power Blue Streak (generally assumed to be similar to the Rocketdyne MB-3 and S-3) will very soon begin at the Spadeadam establishment in Cumberland, managed by Rolls-Royce.

The assertion is made that both the Indian Prime Minister and Defence Minister are adamant in refusing to permit R.A.F. Transport Command to stage through Indian territory with Blue Streaks on board. It appears, therefore, that the test rounds will be carried by the twelve Lockheed C-130A Hercules freighters of the R.A.A.F. (the only aircraft in the British Commonwealth capable of moving Blue Streak on a global scale) and that these aircraft will stage through the rebuilt R.A.F. airfield at Gan in the Maldives (itself the centre of no small political controversy).

POLARIS VARIATIONS

During the past six months the U.S. Navy's Fleet Ballistic Missile System has made extraordinary progress. Some 40 major flight-test vehicles have already flown and those currently being launched from Cape Canaveral closely approximate to the configuration of the operational weapon. Although the FBMS originally envisaged a 5,600-ton nuclear submarine as the carrier vehicle (armed with 16 Polaris), Lockheed's Missiles and Space Division are investigating the practicability of developing a much smaller one-shot submarine with a crew of 15. At the same time the U.S. Navy are evaluating the concept of Polaris missiles based on surface ships, and it has been suggested in *Aviation Week* that an installation may be made upon the nuclear cruiser *Long Beach*.

AIR-LAUNCHED BALLISTIC MISSILES

At least fourteen companies are now competing in the U.S.A.F. competition for Weapon System 138A for an air-launched ballistic missile capable of being carried internally by the North American B-70 Valkyrie. Air launchings of test vehicles have already been made by Lockheed, McDonnell and Martin, using Boeing B-47s and Convair B-58s as carrier aircraft. The specification calls for a weapon some 30ft in length (shortened in some submissions by folding or telescoping) capable of being launched at Mach 3 at 70,000ft and of thereafter flying a distance of about 1,000 miles with a megaton warhead.

TO THE MOON

Speaking on TV in Washington early this month, Dr. Herbert R. York, chief scientist for R. & D. at the Department of Defense, stated that guidance systems developed under the authority of his Department were accurate enough to place a man "on a rather small area" of the moon. Such systems had not been used in previous lunar probes owing to the latter's restricted payload ability. He repeated the previous official estimate of 1965 as the year in which the United States would place a man on the moon (in the absence of any unforeseen major obstacle).

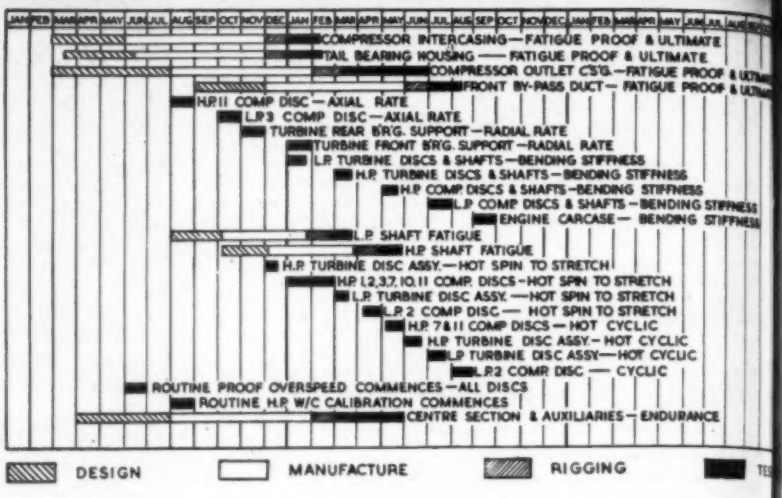
Meanwhile, in a lecture at the Royal Institution, Fred Hoyle, Plumian Professor of Astronomy at the University of Cambridge, described such aspirations as "lunatic fringe stuff." Much better results, he said, could be obtained by sending a TV camera to transmit back pictures "which could then be watched by the comfort of one's fireside."

AGARD ON ASTRONAUTICS

A series of lectures on astronautics will be presented by the University of Rome, with the co-operation and assistance of the Advisory Group for Aeronautical Research and Development (AGARD), at the Consiglio Nazionale delle Ricerche, Rome, during May 18-29. Scientists from NATO countries and professors from Italian universities will attend the seminar, which is intended to be of interest to students and young research workers.

Aero Engine Development

ROLLS-ROYCE CHIEF ENGINEER DISCUSSES THE ART


COMPRESSOR INTERCASING—FATIGUE PROOF & ULTIMATE
TAIL BEARING HOUSING —— FATIGUE PROOF & ULTIMATE
COMPRESSOR OUTLET C'S'G.—FATIGUE PROOF & ULTIMATE
FRONT BY-PASS DUCT— FATIGUE PROOF & ULTIMATE
H.P.II COMP DISC—AXIAL RATE
L.P.3 COMP DISC—AXIAL RATE
TURBINE REAR B'R'G. SUPPORT—RADIAL RATE
TURBINE FRONT B'R'G. SUPPORT—RADIAL RATE
L.P. TURBINE DISCS & SHAFTS—BENDING STIFFNESS
H.P. TURBINE DISCS & SHAFTS—BENDING STIFFNESS
H.P. COMP DISCS & SHAFTS—BENDING STIFFNESS
L.P. COMP DISCS & SHAFTS—BENDING STIFFNESS
ENGINE CARCASE— BENDING STIFFNESS
L.P. SHAFT FATIGUE
H.P. SHAFT FATIGUE
H.P. TURBINE DISC ASSY.—HOT SPIN TO STRETCH
H.P. 1,2,3,7,10,11 COMP. DISCS—HOT SPIN TO STRETCH
L.P. TURBINE DISC ASSY. —HOT SPIN TO STRETCH
L.P.2 COMP DISC.— HOT SPIN TO STRETCH
H.P. 7&11 COMP DISCS—HOT CYCLIC
H.P. TURBINE DISC ASSY.- HOT CYCLIC
L.P. TURBINE DISC ASSY—HOT CYCLIC
L.P.2 COMP DISC — CYCLIC
ROUTINE PROOF OVERSPEED COMMENCES—ALL DISCS
ROUTINE H.P. W/C CALIBRATION COMMENCES
CENTRE SECTION & AUXILIARIES— ENDURANCE
DESIGN
MANUFACTURE
RIGGING

Example of a mechanical rig-test programme for a civil engine (apparently the Conway); the strips are divided into (left to right) design, manufacture and testing

ENGINE development as an art was the subject of a R.Ae.S. main lecture* read at Preston on April 9 by Mr. A. C. Lovesey, O.B.E., B.Sc., F.R.Ae.S., chief engineer of the Aero Division of Rolls-Royce. The following synopsis deals, in the main, with the lecturer's remarks on control of cost and the importance of time in engine development.

"Art," quoted Mr. Lovesey, "proposes to itself an end and looks for a means to effect it," and the aim in aero-engine development was to correct defects which occurred between the drawing board and maturity and to import a higher performance and longer life. After explaining the chain-of-command and the tools that were needed to do the job, the lecturer had turned to the subject of planning and the importance of time in engine development. A detailed plan of the various stages of development was necessary in order that delivery dates to the aircraft manufacturer could be kept. Too much slack allowed in the programme might cause the project to be uncompetitive. If unforeseen contingencies arose —and they usually did—they must be overcome by greater effort, not by the same effort in extended time.

The advantage of a given project or technique was only an advantage at a given time, and loss of time due to protracted development or late decisions seriously reduced the value of any new project.

Why (asked the lecturer) did development of a new engine take so long? And why did it cost so much? It was because a new engine had to be superior in performance, weight and size, and competitive in price, maintenance and life. As the time cycle from inception to service was anything from 1½ to 7½ years statistics of previous development experience proved very helpful. Fig. 1 showed the relatively short time taken to develop the earlier centrifugal-compressor engines, the slowing-up with the introduction of axial-flow engines, and the later improvements stemming from developed techniques and improved facilities. An example was progress in instrumentation; this has been very great, particularly over the last four or five years, and it had been mainly responsible for stemming the trend towards increased development time caused by increasing complexity.

In the development of an engine for civil operation the development engineer might at any time have to take up the challenge of competitive engines. This could effect production—material ordering and tooling (with risks of delay) and inevitably resulted in the scrapping of some development material, with a resultant cost/penalty.

New ideas which occurred during the period between the drawing board and production must not be allowed to influence in the slightest degree the date plan; with intelligent planning the stepping-stones could be laid for the economical introduction of worthwhile improvements in the post-production era of service operation. The importance of very fully considering a development programme against dates could not be over-emphasized. This must be realistic; the dating of an engine and components must be the outcome of careful investigation between the design and manufacturing departments. From the key programme a more detailed breakdown must be prepared covering supply and testing components, internal activities and those required of sub-contractors. These programmes justified a lot of high-class thought and time.

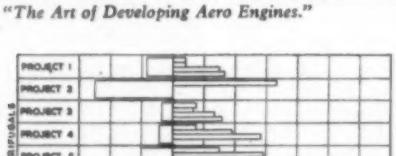
There were inevitably "hard luck" cases on both the manufacture and development sides: late deliveries of engines or components, difficulties encountered in the fabrication of components, or "completely unexpected" failure of a component with a previously unblemished development record. To the seasoned engineer all these incidences were part of the business of development. If unchecked they could result in a slip of the ultimate delivery programme of engines to the aircraft. It became, said the lecturer, a question of deploying one's forces—maybe at the expense of some other project—in order to get back on the date line. Late dates must never go unchallenged or unchecked.

On the control of development costs Mr. Lovesey emphasized the importance of producing the product at the right price as well as at the right time. A firm budget for the overall cost was drawn up when the design had reached a stage where it was known what the various components would look like and of what they would consist. This superseded a necessarily sketchy preliminary budget drawn up at the inception of the project.

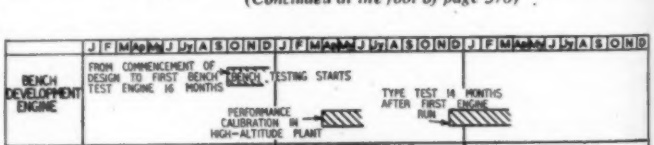
The number of development engines that would be required and the running that would be necessary on them to achieve a satisfactory engine depended upon complexity and was decided by past experience. It paved the way for a budget estimating the

(Concluded at the foot of page 570)

* *"The Art of Developing Aero Engines."*



Some development times for Rolls-Royce projects; the post-design plots for each are respectively (top to bottom), first run to flight, to production, to type-test and to service.
(Right) Typical supply programme for a civil turbojet


J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
BENCH DEVELOPMENT ENGINE
FROM COMMENCEMENT OF DESIGN TO FIRST BENCH TEST ENGINE 16 MONTHS
BENCH TESTING STARTS
PERFORMANCE CALIBRATION IN HIGH-ALTITUDE PLANT
TYPE TEST 14 MONTHS AFTER FIRST ENGINE RUN
FLIGHT ENGINES
METAL MOCK-UP FOR DESIGN USE. PIPES, HARNESS, ETC. 15 MONTHS FROM START
FIRST ENGINES FOR FLIGHT IN FLYING TEST BED 12 MONTHS AFTER FIRST ENGINE RUN
FIRST ENGINES FOR FLIGHT IN PROTOTYPE AIRCRAFT 14 MONTHS AFTER FIRST ENGINE RUN
FLIGHT OF FLYING TEST BED
FLIGHT OF FIRST PROTOTYPE AIRCRAFT 20 MONTHS AFTER FIRST ENGINE RUN
MOCK-UP ENGINES
WOODEN MOCK-UP ENGINE FOR DESIGN USE 9 MONTHS AFTER DESIGN COMMENCES
METAL MOCK-UP FOR AIRCRAFT INSTALLATION CHECKS 20 MONTHS AFTER DESIGN COMMENCES
RIG SUPPLIES
AERODYNAMIC & COMBUSTION RIG TESTING ETC. COMMENCES 6 MONTHS PRIOR TO FIRST ENGINE RUN
A.R.B. RIG TESTS
MECHANICAL RIG TESTING STATIC & ROTATING
PRODUCTION MATERIAL TOOLING & MACHINE RELEASES
TOOLING & MATERIAL RELEASE 18 MONTHS PRIOR TO PRODUCTION DELIVERY OF ENGINES
MACHINING RELEASE 12 MONTHS PRIOR TO PRODUCTION
PRODUCTION DELIVERY OF ENGINES TO AIRCRAFT CONTRACTOR

Air Transport and its Future

AS SEEN BY THE DIRECTOR OF THE R.A.E.

ADDRESSING the special anniversary meeting of the Canadian Aeronautical Institute recently, Sir George Gardner, director of the Royal Aircraft Establishment, took as his title *Some Aspects of Future Air Transport Possibilities*.

Sir George emphasized the convenience, speed and cost factors that made air transport unique but, putting them into perspective, showed that traffic and earnings were small when compared with ships, rail and roads. In spite of its steady growth, he reminded his listeners, it had made only a slight impression on the mass of people even in the areas of highest prosperity. The most obvious gains, of long range, were already established; there might now be profit in further reducing journey times by increased speed.

Growth in air passenger traffic, Sir George continued, would occur as general standards of living rose, as operating costs decreased with progress in aeronautical developments, and in those regions where centres of population were widely separated.

Trend of Costs. The main factors which influence cost and convenience over stages of 100-1,000 miles are block speed, payload and utilization. A study (Fig. 1) of a family of turboprops flying at 350 kt shows that a progressive increase in percentage payload can be carried as stage length is reduced, accompanied by a small decrease in optimum speed. Not much is lost when an aircraft designed for a longer stage is operated over a small stage with reduced fuel load, but when indirect costs of about 10d/c.t.m. are added a reduction in design range from 300 to 200 n.m. might add 15 per cent to the cost per passenger mile. For the type of short-range aircraft with a design stage length of 500 nautical miles the major part of the operating cost is dependent upon first cost, so that operating cost is more sensitive to utilization than that of longer-range aircraft. In the choice between smaller aircraft operating at a high utilization or larger aircraft at a lower rate, the latter can be justified if sufficient extra traffic is attracted.

Freight. Passenger traffic and passenger revenue predominate in air transport, but freight has a greater potential. Assuming that 5 per cent of the value of a commodity is the maximum rate for air transport, one can both identify commodities that are suitable cargoes at various values of pence per ton mile and also predict the relationship between volume of air freight in ton miles and air freight charges. If the rate could be halved from 36d to 18d/ton mile, traffic could increase by 500 per cent.

A fruitful way of reducing costs is by an increase of payload. An increase of payload from 10,000 lb to 100,000 lb on a 275 kt turboprop would reduce operating costs by 30 per cent, but beyond a certain size airfield performance is a limitation. The increase of percentage payload with payload is largely due to some parts of the equipment remaining fixed in weight plus increasing efficiency of fuselage weight per lb of payload. At higher payloads the increase in wing weight with size of aircraft results in a reduced advantage.

Laminar Flow. Recent work has suggested that laminar flow on swept-back aircraft wings should be practical, although with somewhat larger suction quantities than with straight wings. Laminarization of a conventional aircraft on wings and tail could increase L/D ratio to about 30, including the drag equivalent of the pump power; i.e., almost double that obtainable without suction. Including laminarization of the fuselage the L/D could be trebled, but research is needed if provision is to be made for doors and cut-outs.

The most obvious application is for long-range aircraft where the high cruising efficiency can reduce significantly the high fuel load of conventional aircraft. At small ranges the extra weight offsets the effect of drag reduction. At the transatlantic stage of 3,000 n.m., direct operating costs are 15 per cent lower than for a conventional turbojet with the same powerplant characteristics and speed, provided (a) first cost per lb is the same; (b) the maintenance cost per lb is the same; (c) fuel costs are not significantly less than 18d per gal (a dominating parameter in the comparison); (d) the problems of surface contamination can be overcome; (e) the aerodynamic and structural design problems could be solved.

Although further research and operation remain to be solved before this promising idea could be applied to large transport aircraft, there is at least a real incentive to try and solve them.

VTOL and STOL. Is it feasible and is it worth doing? Generally the answer is "yes," provided one is prepared to pay for it. Military needs are obvious; there is great interest in transporting passengers to and from points closer to centres of population, and another possibility—applicable to supersonic aircraft—is the freedom to design the aerodynamic shape exclusively for efficiency at high speed.

If anything, the choice between the many schemes which have been suggested is embarrassing; vertical thrust by the familiar helicopter rotor to propellers, and fans and jet engines in increasing order of jet velocity and decreasing duration of hovering.

With the Short SC.1 [which Sir George described] the excellent response characteristics of the RB.108 engines have given perfectly satisfactory height control, without having to revert to artificial damping. Electrical control signalling is not simply an aid to the pilot but a vital part of the control system; reliability of a very high order is demanded.

As a result of the work done to date autostabilization will generally be required. Automatic take-off and landing may well be desirable to reduce the amount of fuel used, but under reasonable weather conditions the pilot could land in a small area without the aid of a programmed manœuvre. To exploit the potentialities of VTOL we shall have to pay attention to safety in the event of partial power failure, to the noise problem from structural and nuisance aspects, and behaviour in gusts.

All VTOL and STOL schemes involve some appreciable performance penalty. The small difference in total engine-plus-lifting-fuel weight between the extremes of schemes advocated for VTOL suggests that the choice will depend more upon factors of airworthiness and complexity than on pure performance.

Fig. 2 shows the importance of engine weight in VTOL aircraft. A total weight of engine installation of the order of 30 per cent all-up weight (compared with 8-9 per cent for conventional aircraft) is required. Percentage payload is likely to be about one half that of conventional aircraft. The economic account of VTOL therefore seems at present to be rather heavily loaded against easy acceptance. VTOL configurations can become STOL merely by overloading, and there will be pressure to reduce costs by using them as often as possible in this manner.

High-speed Flight. Speed in the air has always been an important selling factor and will continue to be so providing intolerable economic penalties are not imposed. High speeds are encouraged by the jet engine characteristic that efficiency increases with speed, but it is then increasingly difficult to obtain a high aerodynamic efficiency. For subsonic aircraft a meritorious lift/drag ratio might be as high as 20, but this will fall to eight or less by M=2 and at the highest speeds five or six may be difficult to achieve.

Apart from kinetic heating at speeds approaching satellite velocities the temperature of the air in the vicinity of the vehicle becomes so high that the fluid becomes dissociated or even ionized. At the altitudes at which we are then forced to fly air becomes so tenuous that we can no longer consider it as a continuous medium but rather as a stream of particles which may or may not be electrically charged. Between this regime and that which has been the basis of our aerodynamics in the past is the slip-flow regime, where the fluid cannot be considered as continuous, or as a stream of particles. A large research effort can be expected to be brought to bear on these problems in the future.

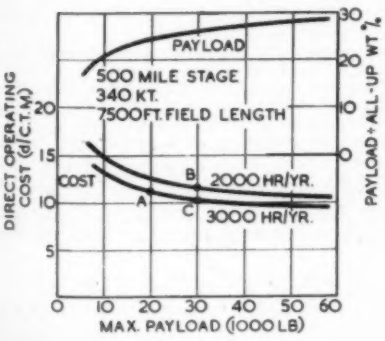


Fig. 1 (left). Effect of payload on costs of a passenger aircraft

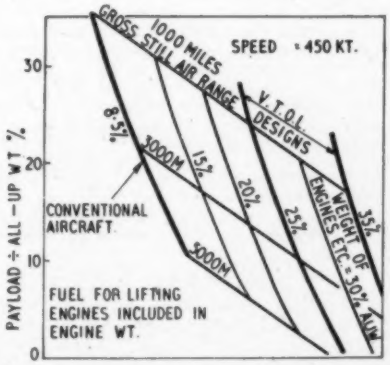


Fig. 2 (right). Percentage payload for conventional and VTOL aircraft

AIR TRANSPORT AND ITS FUTURE . . .

Hypersonic Glider. As cruising speed rises accelerations and decelerations occupy more and more of the total flight time. To use the kinetic energy built up in an acceleration phase as efficiently as possible, the journey can be mainly accomplished during deceleration—thus results the hypersonic glider concept. The lecturer showed that vehicles with a L/D ratio of five and starting at around 200,000ft at 10,000 and 25,000ft/sec could fly 2,000 and 10,000 miles respectively.

The range of the given starting velocity is virtually independent of wing loading, but varies almost proportionally with L/D ratio. The maximum deceleration experienced by the vehicle is also independent of wing loading but is approximately inversely proportional to L/D. The hypersonic glider skims through the edges of our atmosphere at speeds approaching that of satellites, whereas in ballistic flight the journey is accomplished outside the atmosphere and the ballistic vehicle encounters a severe heating problem on re-entry. Heating and deceleration problems in either regime of flight are formidable, but there seems no reason to doubt our ability to surmount them.

The Supersonic Transport. Advances in aerodynamic engine and intake efficiencies will permit reasonably easy supersonic flight in the near future although the direct operating costs are unlikely to be less than existing subsonic jets. Whether increased speed will attract greater load factors is a matter for speculation.

Four years ago Sir Arnold Hall predicted a future for the supersonic transport, but at that time costs seemed to be some two to three times that of the subsonic long-range jet. It is a revealing consequence of the pace of aeronautical progress that today we can estimate costs which are half the previous values. I would like, therefore, said Sir George, to make some crude predictions on the influence of speed on the direct operating costs. A rough approximation of d.o.c. is given by:—

$$C = a\,\frac{W_F}{S}\,\frac{}{W_p} + b\,\frac{W_B}{V_B}\,\frac{}{W_p}$$

where C is is the direct operating cost per ton mile; a and b are constant; S is the stage length; V_B is block speed; W_F is fuel load; W_B is equipped airframe weight; W_p is payload. The first term covers fuel costs and the constant a depends on the price of fuel per gallon and the properties of the fuel load used on the average journey. The second term covers depreciation, amortization, maintenance and crew costs.

In general, fuel costs will increase with speed, mainly because of the large reduction in L/D which will increase the fuel load required for a given range and/or reduce the payload available.

Other-than-fuel costs will be reduced by the direct effect of speed which, in effect, enables more work to be done with a higher earning capacity for the same maintenance, depreciation costs, etc., but will also be increased due to the reduced payload available in a given airframe as a result of the increased fuel load. Both these effects tend to cancel out so that the variation in other-than-fuel costs with speed tends to be less than the variation in fuel cost. Typical values for transatlantic operations using current values for L/D ratio and for fuel and other-than-fuel costs (in pence/short ton/statute mile) are given in the table [top of col. 2].

The most significant effect of speed is the increased traffic that can be handled with a given size of fleets. This reduces maintenance and depreciation costs as well as indirect costs or overhead

Cruising Mach No.	0.8	1.2	1.8	2.6
Fuel costs	3	5	10	12
Other-than-fuel costs	9	9	9	10
Direct costs	12	14	19	22
Indirect costs	12	12	12	12
Total of operating costs	24	26	31	34
Ratio to present day subsonic jets ...	1.0	1.08	1.3	1.4

costs but how important, economically, speed will be in practice is difficult to assess. Some calculations for the London - New York route give results showing that with an operational limitation for a three-hour turn-round at London and two hours at New York, and with a 15-minute frequency, 24 aircraft flying at subsonic speeds (journey time approximately seven hours) can each manage one return trip per day, all with desirable arrival and departure times. Three aircraft grounded for routine checks and one spare aircraft at each end of the route make a fleet of 29. This gives a peak utilization annually of 4,000 hr per aircraft. At M=1.8 (3½ hr journey) 12 aircraft can manage two return trips per day each, though if a 15-minute service is used, two trips either arrive or depart during the night, denoted by the dotted lines. They have little spare time during the day and two spare aircraft are required to make a total fleet of 17 with 3,500 hours utilization.

At M=2.6 (2½ hr journey) two return trips per day are still all that can be arranged and more night trips are necessary. Thus 17 aircraft with utilization down to 2,600 hours and a less attractive timetable results.

Speed, it can thus be seen, is a step function and going to M=1.2 does not, in this case, confer any reduction in the size of the fleet. But M=1.8 offers a significant reduction.

A final point is the possibility of VTOL for supersonic transports which would permit the design of aircraft to be uncompromised by the take-off and landing restrictions that normally apply. Not only will the stowage of vertical lift engines and their satisfactory control create equivalent problems, but the weight penalties and maintenance costs will make an economic civil transport using such devices difficult to achieve. The first generation of supersonic civil aircraft will use conventional aerodromes.

Weather Problems. Finally Sir George Gardner turned to the problems of all-weather approach and landing, upon which the Royal Aircraft Establishment, through the Blind Landing Experimental Unit, has done considerable work. He emphasized that as the approach speeds of aircraft increased, the existing standards of safety could be maintained only by raising the operating limits and hence reducing regularity. To permit routine operations in conditions of zero or near-zero visibility it was necessary to eliminate the final visual phase completely.

Sir George completed his lecture with detailed descriptions of the Leader Cable automatic blind landing system (see *Flight*, October 17, 1959) and of the Televiewer. The latter system, still in the early research stage, aims at presenting to the pilot in bad visibility a picture similar to the airfield landing pattern seen at night in good visibility. This will provide a Manual Blind Landing System in contrast to the Automatic Landing System with the pilot outside the loop. Experiments made both by day and night showed that a pilot could land satisfactorily an aircraft with an approach speed of 135 kt, using a picture of runway lights presented to him on a cathode-ray tube; this speed is not limiting if the picture is of reasonable quality.

AERO ENGINE DEVELOPMENT

(Continued from page 568)

overall cost and establishing the development overheads that must be borne by production engines. Too generous a development programme might well price the final product out of the market while too mean a programme could result in the job not being done in the time allotted. The development art drew an equitable balance between these two factors and was based almost entirely on experience. There was no simple empirical formula; each engine must be judged on its own merits.

The project engineer must see that the budget was strictly adhered to; that every test had a definite objective; and that the test sequence was such as to avoid unnecessary stripping and rebuilding of engines. Cancellation of schemes superseded by later ones was also a very important aspect. If unchecked it could use up quite a big proportion of the total manufacturing time and result in machine capacity being employed in making scrap.

After dealing with mechanical methods and techniques used in engine development, Mr. Lovesey concluded: "With the increase in complexity of engines the development period tends to get longer and it is mainly by specialized instruments that we can hope to reduce both time and cost . . . Working closely to a well-planned programme is essential in order to meet dates and keep development costs within the agreed budget."

PARIS SHOW DAYS

FURTHER details have now been published about the special features of each day of the Paris Air Show. Thursday, June 11, will be the press preview day, with the official opening on the following day. June 14 will be devoted to commercial aviation and the 15th and 16th to private and sporting aircraft. Helicopters will be featured on the 18th and the 19th is to be set aside as an international technicians' day. An "international flight demonstration" will be held on June 20, the Saturday, and the great public air display will form the climax of the show on June 21. A special postage stamp commemorating the test pilots Rozanoff (Dassault) and Goujon (Sud) will be on sale from June 13.

INTERNATIONAL NAVIGATION SYMPOSIUM

THE French Institute of Navigation is organizing a joint meeting of the British and French Institutes of Navigation and the German Ausschuss für Funkortung in Paris from April 28 to 30. The theme will be automatic navigation at sea and in the air, and numerous lectures and discussions will be held at the Hotel des Ingénieurs Arts et Métiers, 9bis Avenue d'Iéna, Paris 16. Further details can be obtained from the French Institute of Navigation at 13 Rue de l'Université, Paris 7. Inertial, astro, doppler, radio and computer fields will be covered by speakers from four nations.

FINANCING THE JETS

PROBLEMS OF THE TRANSITION TO TURBINE TRANSPORT—PART 2

By Stanley Oates

THE four broad categories of capital available to the joint-stock airline are (1) equity funds (ordinary shares), (2) preferred capital, (3) loans and (4) reserves accumulated mainly by the retention of profits and by depreciation. Each category has its own characteristics, and the financial health of the enterprise depends to a large extent on the ratios between each class of capital. These ratios should be so arranged and controlled as to permit the maximum degree of flexibility. A rigid structure militates against the ability of a company either to exploit opportunities or to withstand adversities in changing conditions. The cost of obtaining and retaining capital funds is another important factor and a structure that is expensive to maintain is an obvious handicap. Although any general rule must be treated with a certain amount of reserve, a reasonable assessment in the case of air transport industry would appear to be that equity capital should exceed loan capital by at least 25 per cent.

Against this background it is interesting to analyse the funding of the £240 million additional capital raised by 12 leading U.S. international and domestic airlines during the period 1955-1957. Of this amount, 65 per cent was arranged in the form of long-term loans with repayment extending over 20 years or more; 28 per cent was funded as medium-term loans with repayment stretching over ten to 20 years; an insignificant portion was arranged as short-term lease; and only 7 per cent was raised by the issue of equity capital.

An analysis of the capital structure of these 12 carriers is available from the balance sheet of their total assets and liabilities at the end of 1956, a time when equity markets were favourable. At that date, their loan capital accounted for 38 per cent of total investment; retained profits for 32 per cent; capital reserves for 21 per cent; and issued capital for 10 per cent. Of the issued capital, £5½ million was preferred and £31 million was common, or ordinary, stock. The common stock was equivalent to 27 per cent of profits retained for use by the airlines; and capital surpluses together with earned surpluses equalled 52 per cent of total investment.

It is possible to project the change in this 1956 structure that financing plans will have brought about by the early sixties. An assessment of the total new funds that this group of carriers required at the time this balance sheet was drawn up indicates an amount of £670 million. During 1957 and 1958 further orders have been placed, resulting in total commitments in the middle of 1958 of £900 million. To this figure must be added a further amount of approximately £180 million for new ground equipment giving a gross requirement of £1,070 million. When working capital, debt-retirement, proceeds from sales of surplus equipment, and other miscellaneous requirements are taken into consideration, the total cash requirement of these 12 carriers may be expected to rise by £1,250 million by 1962.

A substantial portion of this amount will be funded by depreciation of equipment now in service, together with partial depreciation of equipment delivered prior to the end of 1962. Based on current write-off rates, depreciation should generate approximately £430 million. A further amount will also be provided by the retention of profits, this policy being assisted by the payment of dividends in the form of issued shares rather than in cash. If it is assumed that profit margins are between 8 and 10 per cent on investment (after allowing for dividends) approximately £160 million will be provided from that source. A further £125 million may be expected to be raised through other techniques such as deferment of income-tax payments. This leaves a balance of £500 million to be found in the form of new capital.

The dangers of this situation are clear when these funding arrangements are related back to the position at the end of 1956. Although substantial portions of the loan capital outstanding at that date will have matured for repayment prior to the end of 1962 (some of the new funds arranged during the past two years having been provided for that purpose), the weight of loan capital, relative to equity share capital, will be considerable. If it is assumed that none of the 1956 loan capital remains for repayment at the end of 1962, and that the whole of the outstanding £500 million new finance will be obtained in the same ratio as the £240 million that was arranged in the two years to the end of 1957 (i.e. 93 per cent loan capital and 7 per cent equity) then the total loan capital at the end of 1962 will amount to £465 million. Compared with this figure, issued capital and capital surplus will stand at £150 million, retained profits at the same date would amount to £280 million, giving a total stockholders' equity of £430 million—*or rather less than the total for loan capital.*

In practice, of course, the airlines' creditors will not allow such a ridiculous situation to arise. The problem therefore is this: if capital needs cannot be reduced there must be found a way to raise equity capital. This will be necessary not only to maintain acceptable debt-to-equity ratios, but also to ensure adequate funding of the commitments. In some cases, the banks and insurance houses are already insisting that a condition of the granting of loans must be the issue of equity stocks.

The situation outside America is influenced by the extent to which financing arrangements are determined by governments rather than by airline management. The preservation of a satisfactory ratio between loan capital and equity capital is of little importance in the case of carriers such as B.O.A.C., B.E.A., Air France and Sabena which have for many years been largely capitalized through the issue of fixed interest-bearing stocks or loans. Nevertheless, there are several problems common both to airlines with this type of structure and to joint-stock carriers. In the eight years to the end of March 1958, for example, B.O.A.C.'s total fixed charges for interest on capital amounted to £13 million —equivalent to 4 per cent of total revenues during the period of £313 million. The extent of this burden is illustrated by comparison with Pan American: over the same period PanAm paid slightly less in dividends (£12 million) although revenues at over £600 million were well over twice the level for B.O.A.C.

The burden of interest repayment during the 1960s will be extremely onerous to airlines throughout the world. In the case of the U.S. international and domestic trunk carriers, interest repayment calculated at an average rate of 4 per cent would amount to £18.5 million in 1962. Although this amount would decrease annually as loans matured and were repaid, the heaviest interest charges will fall during the initial years of operation of new types of aircraft. This burden will not fall unevenly, because some carriers are faced with the necessity of repaying debts at rates up to 6 per cent; in many cases the repayment conditions of the institutions are severe, and the loans carry conditions such as restrictions on further new investment and the definition of minimum amounts of working capital and net worth. Two American airlines in particular—Capital and Northwest—have already been prevented from completing their equipment programmes as a result of pressures exerted by their long-term creditors.

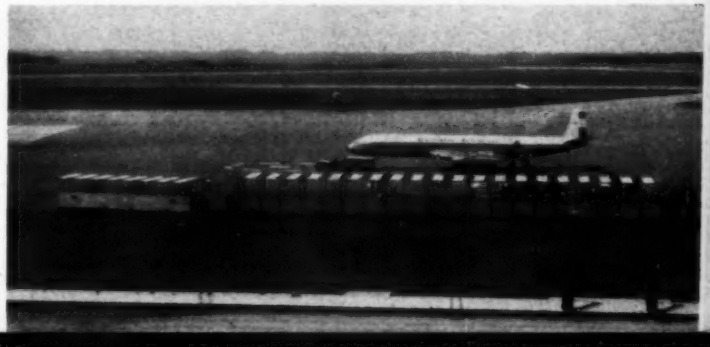
Apart from a possible traffic revival, as mentioned in Part 1 of this article, three other developments could bring some relief to the airline industry: the decline in revenue rates could be arrested; the rate of new investment could be cut back; and the level of operating costs could be reduced.

The arguments in favour of increased fares has its limitations. Recent fare increases in Brazil are reported to have reduced traffic over certain routes by as much as 60 per cent. A more flexible fare structure is probably the course to adopt, air transport being encouraged to charge what the market will bear—increasing fares where demand is strong, reducing fares where demand is weak. As regards a possible reduction in operating costs even the manufacturers have for the most part ceased to claim that the first generation of jets will offer cheaper costs per ton mile. Apart from normal development and introductory costs, depreciation will be an increasing burden in most carriers' operating accounts. Fortunately there are at last signs in the industry that an extension of depreciation periods would be an acceptable way of cutting unit costs and thus increasing profit margins.

Although some reduction in new investment is probable, the extent of this is unlikely to be considerable for—despite acute financial discomfort—the industry has generally remained optimistic in its outlook.

Of all the four possibilities, a recovery in traffic coupled with a more imaginative setting of fares would appear to be the direction from which the industry's salvation will come. It remains to be seen whether the passenger appeal of the jets is sufficient, after the initial novelty has worn away, to restore the rate of traffic growth to a level high enough to justify the industry's investment.

One of the most recent carriers to take delivery of jet airliners—in this case Comet 4s—is Aerolineas Argentinas



The Aircraft Industry—A National Asset

LECTURES OF GREAT SIGNIFICANCE DELIVERED AT SOUTHAMPTON

THE Institution of Production Engineers (Southampton Section) held its 7th Conference on Problems of Aircraft Production at the University of Southampton on April 16 and 17. The theme was "The Aircraft Industry—a National Asset" and the papers and discussions were of the highest significance both to the aircraft industry and to the nation.

The Conference assembled at noon on April 16 and, following a luncheon (reported on page 575), the Lord Sempill Paper was delivered by Lord Douglas of Kirtleside, G.C.B., M.C., D.F.C., under the chairmanship of the Rt. Hon. the Earl of Halsbury, F.R.I.C., F.Inst.P., M.I.Prod.E. Lord Douglas's paper was entitled *The Operator's Point of View*. On the evening of the same day Mr. Peter Masefield, M.A., F.R.Ae.S., M.Inst.T., F.I.Ae.S., C.I.Mech.E., spoke on the subject of *The Industry*, under the chairmanship of Mr. D. L. Wiggins, M.I.Prod.E. On April 17 Mr. Stanley P. Woodley, M.B.E., M.I.Prod.E., addressed the assembly on *The Impact on Other Industries* (chairman, Mr. Cedric Sumner, M.I.Prod.E.); and later in the day there was an open forum on *The Importance of the Aircraft Industry in the National Economy*. The chairman was Professor E. J. Richards, M.A., B.Sc., F.R.Ae.S., and on the platform were Sir Arnold Hall, Lord Douglas of Kirtleside, Mr. Peter Masefield, Mr. Eric Turner, and Mr. Stanley P. Woodley. The Conference was closed at mid-day on April 17 by Mr. J. B. Turner, M.I.Prod.E.

THE OPERATOR'S POINT OF VIEW

By Lord Douglas of Kirtleside

LORD DOUGLAS opened his lecture with an introduction wherein he remarked that about 650,000 people are employed on aviation activities in the United Kingdom. He went on: "Rather more than half this number are in the aircraft, aero-engine and associated accessory manufacturing industries; 6 per cent are in the scheduled airlines and the majority of the remainder in the Forces. The aircraft, aero-engine and accessory manufacturing industries, therefore, constitute the most important part of Britain's total aviation effort. This industry has earned some £800 million in foreign exchange since the war and is at present adding to that total at a rate of about £150 million annually." Lord Douglas concluded this preliminary section with these remarks, "The United Kingdom Government has to decide whether it can afford to reduce its expenditure on aircraft research and development to the extent which is apparently justified by changing defence requirements. Such a reduction would result in a rate of aeronautical progress in this country which would be quite inadequate to maintain the competitiveness of British transport aircraft unless—as seems unlikely—all other countries reduce their own expenditure in this field to a similar extent."

Going on to discuss the importance of the aircraft industry Lord Douglas remarked that it was probable that something over 90 per cent of the value of an exported aeroplane was "pure export"—largely highly skilled home labour. This ratio compared with an average of about 75 per cent for United Kingdom exports of manufactured goods as a whole. Britain, he said, had been largely responsible for large numbers of technical innovations in the past and many of these had been in fields related to aviation. Notable examples in recent years were: gas turbines; radar (and many other developments in the field of radio and electronics generally); new manufacturing processes (machine tools, synthetic adhesives, new paints and finishes, new types of structure); and advanced new materials of many kinds (plastics, synthetic rubbers, light alloys, very high-strength steels and heat-resisting materials—some of which, for example, had made major contributions to the development of the gas turbine). These technical innovations and many others were the result of the inventive genius and the high level of technical skill which had been fostered in this country during the past 150 years. These were, indeed, among our greatest national assets. The United Kingdom must exploit them to the full for its economic wellbeing, and the export of aircraft was one of the best ways we could do so.

Because aeronautics was one of the most "sophisticated" of the technologies, progress in this field had an important effect on the rate of advance in many branches of industry, even though these might not be directly related to it in any way. A country's competitiveness in international trade in the modern world was controlled to a large extent by the contribution which it made to scientific and technical progress generally. There was no doubt that aeronautics was one of the "key technologies" from this point of view and that a country which lagged in aeronautical development would have its whole technological effort impaired.

Discussing air traffic Lord Douglas said, "The United Kingdom at present carries 5 per cent of the world's total air traffic. This percentage compares unfavourably with our 30 per cent share of the world's seaborne trade. (It is, however, relevant to note that the latter figure is unlikely to be maintained if the current diversion of sea trading to 'flags of convenience' continues.) There are well-known historical reasons for the United Kingdom's ascendancy in shipping. There are equally good explanations of our slow start in air transport, compared with the United States, after the Second World War. The Americans provided the major share of Allied air transport capacity during the war and this enabled them to establish themselves in a strong position immediately it was over. Today they still carry 35 per cent of international air traffic, compared with the United Kingdom's 14 per cent. In addition, U.S. domestic air traffic alone represents no less than 50 per cent of the world total. These percentages are all related to total traffic in the Western World and exclude Russia and China. No precise figures are available for these two countries, although there are indications that their air traffic may now be approaching a level equivalent to about 30 per cent of that in the West."

Discussing British airline equipment later in his lecture Lord Douglas remarked that British aircraft had contributed only about 30 per cent of B.O.A.C.'s total output since the war and 75 per cent of B.E.A.'s total output since 1946.

A major division of the lecture was "Transport Aircraft Development Since the War." In the course of this the lecturer said, "The only conclusion which can be drawn . . . is that the United Kingdom has not been particularly successful in the first phase of its attempt to compete with the Americans and establish itself as a major producer of transport aircraft. If we are to do better in the future and, as has been suggested in the first part of this Paper as a nation we cannot afford to do otherwise, we must apply the lessons of the past 13 years and adjust our policies so that they take account of the lessons and experience which have been so dearly bought."

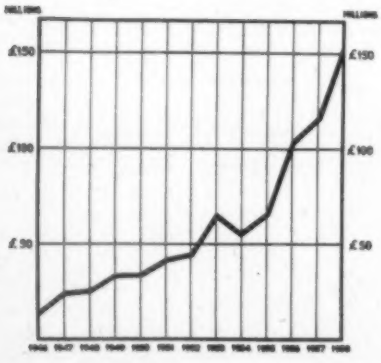
Lord Douglas gave these as the main lessons to be learned from the past:—

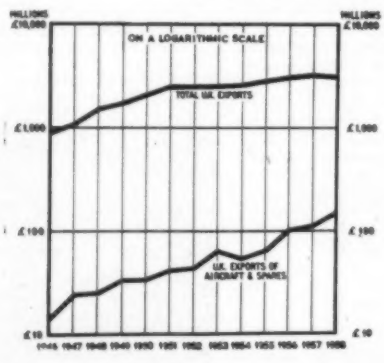
(1) Our aircraft manufacturing resources should be concentrated on a narrower front in the civil field. In the past, the United Kingdom has attempted to develop and market too many overlapping types of major transport aeroplane.

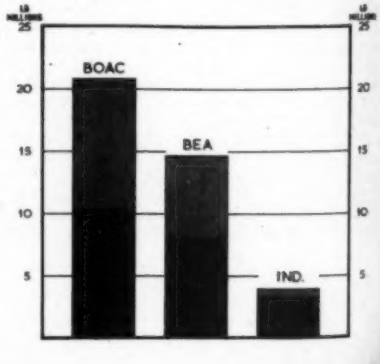
(2) Greater effort must be directed at developing British transport aircraft more rapidly and more thoroughly. A greater initial investment is required on the development of new designs so as to have a larger number of each new type available for test and development flying before it obtains its Certificate of Airworthiness and enters airline service. More ground testing of components is essential and more intensive and extended flight testing is needed to eliminate defects so that these can be exposed and corrected before passenger-carrying operations start.

(3) No British firm should be expected to undertake more than one major transport design simultaneously. In this connection, it is significant that no American manufacturer—even such large companies as Boeing, Douglas, Convair or Lockheed, which have several times the resources of the largest British firms—has, in the past, undertaken the successful development of a second basic design of large transport aeroplane while

Three illustrations from Lord Douglas's lecture: British exports of aircraft and spares, 1946-48; U.K. aircraft exports v. total exports for the same period; and total all-up weight of post-war British aircraft purchased new, or on order (the grey areas indicate outstanding orders)







still engaged in the full-scale development of its previous major civil type.

(4) Every new British transport aeroplane should be developed in close association with a United Kingdom airline, which should also be the first operator of the type. Under present conditions, it is most unlikely that a successful airliner can be developed without a wholehearted manufacturer/operator association. This joint effort must extend from the initial framing of the new design to meet an agreed specific requirement right through the subsequent development, and must continue during the aircraft's service life.

(5) Arrangements are required for Government support of the development of certain important types of transport aeroplane in categories which can be expected to have good export prospects, although they are unlikely to be of interest to either of the British Airline Corporations as *major requirements*. B.E.A. and B.O.A.C. might order small numbers of such aircraft "off the shelf" to meet *secondary requirements*, if they are first developed and initially brought into service at the Government's or some other airline's expense. There should be Government sponsorship of the development of such types, together with financial assistance to a selected United Kingdom airline—be it Corporation or independent—which undertakes the rôle of first operator.

(6) For the next decade, we should concentrate primarily on the "bread-and-butter" types which will carry the great bulk of the world's air traffic for a considerable period ahead. In current circumstances, the subsonic jet is becoming the "bread-and-butter" type for trunk-route services, while the turboprop is falling into place as the powerplant for smaller second-line aircraft and possibly, in the larger sizes, for certain low-fare and freight services.

(7) The development of longer-term projects (supersonics, vertical take-off and landing, boundary layer suction, etc.) should not, of course, be neglected if we intend to continue in the aircraft manufacturing business. The next major step in transport aircraft development will be to supersonic designs, but this step will not be taken for some years. Because of the enormous technical problems to be solved, development of supersonic transport aircraft will have to be started soon if we are to compete in the next era of aircraft manufacture, but the airlines will not be able to introduce these new types into general service until after they have obtained an adequate return on their current very large subsonic jet investment. For the time being, supersonic aircraft and other advanced projects *must* take second place to the primary objective of completing development and then selling the "bread-and-butter" types to which the United Kingdom is already committed. Failure to do this would be disastrous, but is an easy mistake to make in a business which is as spectacular and swift-moving as aircraft development. There is always a strong temptation to go for something better. We should remember, however, that the airlines are naturally cautious about radical developments. They prefer something which, while being competitive, they can be reasonably sure will work satisfactorily. The airline industry is now committed—probably for a period of between 10 and 20 years—to the subsonic jets which are just beginning to come into service.

After discussing the operator's part in transport aircraft development Lord Douglas went on to survey airline costs of sponsoring new aircraft. In this connection he said that it appeared that the short-term adverse effect on B.E.A.'s financial results today of introducing one new major type every four years was of the order of £1,600,000 spread over the four years, or, say, £400,000 per annum. Later he said, "B.E.A. would have preferred to have introduced its own jet, the Airco D.H.121, into service in 1964 at a proper interval after the introduction of the turboprop Vanguard in 1960. However, the competitive situation which is clearly going to develop in Europe following the 'jet buying spree' by airlines all over the world in 1956-58 forced B.E.A. to order a small number of Comets for service from 1960 as 'interim jets' to supplement the Vanguards. It appears that the addition of a further new type to the basic aircraft programme (which is working on its normal four-year cycle) adversely affects B.E.A.'s financial results by a further £500,000 spread over the life of the aircraft—with the Comet equivalent to £100,000 per annum . . . In present circumstances, with B.E.A.'s planning and organization geared to the introduction of the Vanguard and Comet almost simultaneously and of the D.H.121 four years later, the Corporations' financial results are probably being adversely affected by these new type introduction activities to the extent of about half a million pounds a year. The adverse effect will be rather greater than this amount during the first two years of service of the new types (1960 and 1964) and will fall away to a rather lower figure in the years between."

Lord Douglas introduced his conclusions with this remark, "This Paper has stressed the contribution which 'sponsoring airlines' make to transport aircraft development. This is because, from the operator's point of view, the importance of this contribution is the outstanding lesson of the post-war years." He added that the financial burden on an airline was substantial and amounted at the present time to an average adverse effect on B.E.A.'s financial results of perhaps £500,000 per annum. In addition, the airline bore the risk of the new aircraft being unsuccessful. However, this contribution—and a parallel one by B.O.A.C. —was absolutely essential if the United Kingdom was to continue to manufacturing transport aircraft.

Having set out his conclusions, Lord Douglas said, "In practical terms, the above conclusions add up to a need for this country to pursue with determination and without loss of confidence its established transport aircraft programme. The 'bread-and-butter' types already in service or under development cover almost all the important categories in which the world's operating industry is interested. It may be that some redistribution of effort is desirable in one or two directions to reduce duplication and plug potentially serious gaps, but there is nothing in the existing programme which realistic thinking and sensible policy-making cannot put right. In the light of development during the past two or three years, it is perhaps unfortunate that the British programme has placed so much emphasis on large turboprop types and that we are so late in the field in some of the jet categories. However, overall, the United Kingdom's position is not unsatisfactory provided the Government, and the manufacturing and operating industries, press forward together in the task to which they have jointly set their hands."

The lecturer concluded by saying that it might be advisable to undertake from scratch the development of one further major type: a relatively small "Viscount replacement" jet. "If these steps are not taken," Lord Douglas concluded, "we will very likely squander our chances of further worthwhile returns on a prodigious 13-year investment."

THE INDUSTRY'S POINT OF VIEW

By Peter G. Masefield

THE industry's need, said Mr. Masefield, was the creation of stable employment to provide a steady contribution to the national income and a foundation for national security. The particular objective was to produce, and to sell at a profit, competitive types of aircraft designed to meet and develop demands in both the home and world markets. Ranged against this was the problem that the cost today of producing anything in the way of advanced aircraft had reached financial proportions which few firms could contemplate on their own. The trouble was that this business was bedevilled by aspects of national prestige, by domestic politics and by the effects of the vast defence budgets of the U.S.A. and the U.S.S.R., which had brought an acceleration in the rate of advancement of the frontiers of technical knowledge.

Since the war the level of employment in the industry had averaged 220,000 men and women, 50,000 of them designers, draughtsman and technicians and 70,000 skilled tradesmen of one sort or another. These were the people, said Mr. Masefield, we must endeavour to keep in the industry. In the past few years substantial numbers had crossed the Atlantic, whilst those in the industry as a whole had fallen off from 267,000 in January 1957 to 246,000 in March 1959. Skilled manpower would be attracted to remain in the industry and in the country only if it could be shown more clearly than is apparent at present the path ahead for British aviation.

There were, he continued, five present markets: (1) transport aircraft; (2) general aviation aircraft; (3) manned military aircraft; (4) guided missiles and (5) helicopters. The field was wide but the markets highly competitive. The rate of expenditure in the U.S.A. and U.S.S.R. had unbalanced the financial background to development and production; aircraft were being produced today which could not be justified either in terms of cost of fabrication or cost of operation. These facts had resulted in a situation which was placing the British aircraft industry in jeopardy, and the basic issue was whether it could remain much longer in the Big League of military and civil aeronautics. Epitomizing the problem was the urge to develop a supersonic transport. To do the job properly and it was not worth doing otherwise—there was a need for a national outlay of not less than £150m, with more to follow.

The injection of the jet transport aeroplane into the pattern of airline progress towards self-sufficiency had certainly been halted for a time. Most serious for the manufacturing industries on both sides of the Atlantic was the check on the ability of the major airlines to order new airliners at a sedate but continuous pace, sufficient to keep design teams and production staffs in steady employment. With the change in military requirements brought about by the progress of guided flight this posed a basic problem for the future of aeronautics in Great Britain.

Examining the trends of production since the war, Mr. Masefield commented that whereas civil construction accounted for a very small percentage of the output in 1945, it represented some 40 per cent of the value of the output in 1958. The steadily declining percentage of military orders—as a result of abandoning any attempt at the development of supersonic heavy bombers—was of enormous consequence to the industry, the more so because it came at a time when the civil airlines were uncertain of their economic future.

In 1958 the turnover of the U.S. aircraft industry was nearly ten times that of the British, and the value of U.S. military orders—ten times the equivalent of the British figure—accounted for some 88.6 per cent of the whole. What these American statistics meant was that the U.S. manufacturers were able to compete in the civil markets primarily as a result of vast defence budgets. Quite obviously the U.K. could not hope to compete on this ground.

Nevertheless, since 1945 the British aircraft industry had achieved exports to the value of £800m, £220m of this being for civil aircraft and equipment. Last year British aeronautical exports amounted to some £160m—more than 11 per cent of the country's total engineering exports. About 50 per cent of 1958 exports were civil orders.

As far as it could be stated, at the beginning of 1959 we had 28 major types of aircraft and missiles in production. There were also some 12 major types in the design, prototype or pre-production stages. Of the total of 40 types, 23 were military and 17 civil, and there were unfulfilled civil orders for some 150 aircraft, amounting in value to approximately £230m.

Comparing production costs between the U.S. and British industries, Mr. Masefield made the interesting point that the value of the major U.S. civil types on order amounted to £13.7 per lb of empty weight against £14 per lb of empty weight for British ones. The similarity

The Aircraft Industry—A National Asset . . .

of these figures indicated that the higher labour costs of the American industry were offset by longer production runs.

Only five new types of British manned military aircraft were on order and we had, therefore, to look to civil orders—plus diversification—for our health in the future. The U.S.A. was building a preponderance of aircraft in the heavy and light classes, but the middle range was not so fully covered and this might well be the most fruitful province for future British efforts. The two most important markets for the British aircraft industry appeared to lie in (1) the transport aircraft and (2) the guided missiles category.

A point of fundamental importance in the British transport field was the "fly British" policy. Recently, Government support for British transport aircraft had languished and we were now at a critical stage in the provision of future bread and butter types. Experience of producing the Vanguard, VC,10 and D.H.121 without government support, even though ordered by the Corporations, might well result in making future aircraft development impossible without government assistance.

Strong reasons why British airlines should "fly British" were (1) large capital sums needed for aircraft and spares were spent in the home market; (2) exports were developed on the basis of a healthy national market; (3) national prestige was built up; (4) there was an indirect benefit to national defence; (5) no drain on foreign currency was involved and (6) new British transport aircraft could only come by this course. It might well cost a British airline £½m to place a new aircraft in service, but from the national viewpoint it formed a basis for civil exports of many times this figure. An order for B.E.A. or B.O.A.C. "primes the pump"; it does not provide the wherewithal for a manufacturer to "wash his face."

The sums involved in developing transport aircraft were very large, the risks very great, potential profits small. "Can the British aircraft industry," Mr. Masefield asked, "hope to survive economically on such a basis of predominating civil orders unless government support is forthcoming?" His own answer was an emphatic "*no*." However much rationalization or amalgamation went on, against the vast military backed effort of the U.S., we as a nation could stay in the Big League only on the foundation of a comprehensive national policy towards future British transport aircraft.

It all added up, he said, to just this: *"Unless a clear and concise government policy towards research, development and procurement of British transport aircraft is formed within a very short while, there will be no further major British transport aircraft beyond the generation now going through its labour pains."*

This was the burning question-of-the-hour. Development costs had apparently been estimated by the Supersonic Transport Committee at a little less than £100m each, which might well be an under-estimate. The types suggested had relatively low supersonic speeds, because it was said that the technical problems involved were likely to be less difficult. But the fact was that the United States already had bombers flying (B-58 at M = 2)—or about to fly (B-70 at M = 3)—of substantially better performance. Whatever the merits of particular speeds, it was commercial folly to shut one's eyes to what was proceeding elsewhere. The United States now has experience of long range *cruise* at M = 2. Hence we came to the point of whether M = 2 was of interest if somebody else was at the same time—or earlier—flying an M = 3 aeroplane. Would B.O.A.C., for instance, order a British 1,200 m.p.h. transport aircraft when PanAm was about to compete with a 2,000 m.p.h. one? History provided the answer.

If we were to engage in the supersonic race at all, the decision as to the right speed to select was critical. M = 3 (2,000 m.p.h.) is more difficult and more expensive than M = 1.2 or 1.8 and would take longer—but it *was* competitive. If we should, in fact, decide to address ourselves to the task of developing and producing a British 2,000 m.p.h. transport for service by 1970, we should have to face a pre-production sum of perhaps £150m with no supersonic bomber experience available as a foundation. Should we challenge the U.S.A. in its own field?

If we did, it might demonstrate the level of our national technical competence, although the cost would be very heavy. If we did not, we should be out of this particular field for all time.

We were in competition for a slice of the business represented by the replacement of 250 civil aircraft per year against American types produced in parallel with orders for military versions of the same aircraft. In this connection a clear responsibility of the British Airways Corporations was to give a lead to the industry on the types of aircraft they would require to operate six to ten years hence; and in the future these types would certainly include a supersonic transport. Should we in the U.K., Mr. Masefield asked, engage in a head-on competition with the U.S.A. for a supersonic airliner which the Americans will build anyway? Or were there possibilities of a collaborative—and imaginative—Anglo-American approach?

Another field for imagination and endeavour was the business of general aviation; quite how big this was in the United States was hardly realised in the United Kingdom. Manned military aircraft were a less encouraging future field, and as for mergers, an amalgamation to do less work had few obvious advantages. One outlet for unused fixed-wing skills was, of course, guided weapons and G.W. industry appeared likely to develop as a small, highly sophisticated entity, employing relatively small staffs against a high level of technological expertise.

Finally, of the "rotating-wing brigade," Mr. Masefield said that "One way and another" he believed that we could expect a small but steady helicopter development, with a heavy responsibility on the Government to keep design teams together with an adequate flow of forward orders in the military field.

In all the 50 years of the British aircraft industry, he concluded, there had never been a time of decision such as this. "We need that clear statement of a Government lead which can be the only means of pointing the way ahead and of building on a foundation established through fifty years of endeavour."

THE IMPACT ON OTHER INDUSTRIES

By S. P. Woodley

THE third of the prepared papers, Mr. Woodley's lecture discussed in some detail the influence of the aircraft industry on technological progress. "Despite the multiplicity of problems with which it has been beset, or perhaps because of them," said the lecturer, "the impact . . . has been a fruitful one. From research into production development have sprung new ideas, know-how and techniques of direct benefit to other industries."

Enlarging on his theme, Mr. Woodley suggested that the benefits the aircraft industry brought about might be classified as a stimulus to overall technical education, scienific progress and contributions to allied industries; wide-range impact on development in the field of general engineering and in the development of new materials; and the development of by-product industries.

The aircraft industry, he said, was among the first to establish and finance apprentice schools—a contribution to the country as a whole and, judging by the inducements offered to men trained in the aircraft industry, to the world at large.

There were parallels between the aircraft industry and nuclear engineering, both of which absorbed a high intellectual content. Dynamic heating, heat-flow transfer and aerodynamics had parallels in the nuclear field, and mathematical solutions evolved by the aircraft engineer to solve his own problems could be applied with little modification. The problems of remote control and servo operation were also encountered in reactor design. In the application of electronics and instrumentation both industries required large numbers of identically trained technicians and the background of aircraft design had proved tailor-made to the nuclear industry.

The training of engineers that had been necessary, said Mr. Woodley, had been accompanied by a striking improvement in the status of the engineer. "Our future, indeed our survival, depends upon the development of new techniques and new industries. Without adequate rewards the qualities that make this development possible will wither—a fact well recognized by the aircraft industry to the benefit of others."

A second classification of benefits was the impact of engineering techniques on general engineering and on the development of new materials and processes. Had it not been for the aircraft industry, it was doubtful whether aluminium (for example) would have reached its present state of development. Its commercial and domestic applications had been directly stimulated by the initial search for lighter and stronger structures. And if titanium, once described as a wonder metal, were ever applied commercially or in the general engineering sphere it would be entirely as a result of development for the aircraft industry.

In the development of machine tools the impact of the aircraft industry had been most marked. At first there had been almost no machine tools available which could produce complicated "sculptured" components rapidly and economically; but within a short time new tools employing high-speed milling heads and copy-milling techniques had been devised.

A new method of metal removal recently developed by the aircraft industry would without doubt find uses in other industries. This was chemical erosion; it was so simple and economical of labour that it must have a wide appeal.

The aircraft industry's ready acceptance of new ideas was exemplified most recently by the development of electronic tape-controlled machining processes with their distinctive advantages in production of one-off jobs and in the elimination of tooling necessary to manufacture highly specialized piece parts. The aircraft industry recognized almost immediately that this technique was tailor-made for its requirements, but it was possible that as a result of the recession with which the industry was now faced the rate of development in the employment of this new technique would be drastically reduced.

The machine tool industry itself had benefited considerably from the problems which had beset the aircraft designer and producer, from their readiness to exploit new avenues of approach and from the initial machine tool development that they had undertaken. Many inventions and new techniques would have remained undiscovered, undeveloped and unadapted had it not been for the specialized requirements of the aircraft industry.

Development of turbojet and turboshaft engines, for instance, had also influenced other industries. Exclusively an aircraft development, these engines had been used as prime movers for the propulsion of boats, ships, cars and trains, for the driving of pumps and generators, and for other industrial power requirements. And design studies into the application of nuclear propulsion for aircraft would undoubtedly result in lighter and better shielding techniques, contributing to the future efficiency of commercial powerplants.

This country had an enormous investment in the aircraft industry, which had yielded much in the fields of research and knowledge and in the establishment of a vigorous growth that was now withering through lack of support. Without support the general tenor of research and development would decline, to the detriment not only of the industry

The Aircraft Industry—A National Asset . . .

itself but of all other fields of commercial enterprise. The acquisition of technical knowledge was an intangible which could not be evaluated, and whilst present government policy might be economically desirable it could also lead to a drastic decline in our aviation export business.

Criticism of the aircraft industry for its prodigality with public funds had been common, but it was often overlooked that the industry's participation in Britain's defence had been sought in artificial circumstances and loaded with exacting requirements. There was hardly an aircraft company in the United Kingdom which was not broadening its scope. "Whether the problem is to be overcome by group formation, by diversification or re-deployment," Mr. Woodley concluded, "it will never be said of the aircraft industry that it tamely lay down and died."

THE DISCUSSION

BY custom there was no discussion on the Lord Sempill paper and remarks from the floor were confined to the papers read by Mr. Woodley and by Mr. Peter Masefield—the latter an exemplary *ad lib* discussion supported by first-rate colour slides.

Commenting on Mr. Masefield's remark that there was a market for only ten British supersonic aircraft, Mr. W. E. W. PETTER (Folland) said that a manufacturing decision would be a purely political one. The problem was how to employ 80,000 skilled people, but a supersonic transport and the TSR.2 could swamp our manpower. He knew from experience that big technical jumps could not be made without a risk of failure and he agreed that a committee (and not only a technical body) should be set up to study the questions. In reply Mr. Masefield said that he thought the cheapest way of carrying, say, 100 people might be to make an unpressurized aircraft powered by two large piston-engines. MR. ERIC TURNER (Blackburn) said that he was encouraged that almost for the first time there was agreement within the industry itself. We ought to take advantage of lower labour costs in the United Kingdom to produce a very cheap-to-operate aeroplane in quantity.

MR. A. VINES (Fairey) advocated a British "aerial tramp steamer" for the transport of goods all over the world. MR. SPENCER (Jessops) asked Mr. Masefield why, if three supersonic air transports were going to carry all the British transatlantic traffic, how he could justify his remark that 100 units were needed to make the manufacturing price economic. Mr. Masefield replied that that was why he thought that supersonic transports were not worth while.

Discussing Mr. Woodley's lecture, MR. H. G. GREGORY (Fairey) asked if the lecturer could distinguish between the impact the aircraft industry had made on other industries and its own diversification. MR. M. SEAMAN (British Oxygen) asked was it not the rôle of the learned institutions to be precise policy-forming bodies and MR. J. V. CONNOLLY (Management Centre) asked if it might not be a good thing to reduce the progress in nuclear and aircraft engineering in order to advance technical research in other fields.

INAUGURAL SPEECHES

AT the inaugural luncheon on April 16, under the chairmanship of J. B. Turner, M.I.Prod.E., the speakers were the Worshipful the Mayor of Southampton, Alderman R. R. H. Hammond, O.B.E., J.P., and Air Chief Marshal Sir Claude Pelly, K.C.B., C.B.E., M.C., A.D.C., Controller of Aircraft, Ministry of Supply. Sir Claude said: "I believe it is worthwhile pointing some contrast between the situation which seemed to face the aircraft industry after the publication of the 1957 White Paper on defence, and now, after the White Paper of 1959. By the time the 1959 Paper was published, we had instructions to proceed with three major military projects—the TSR2, a medium-range freighter and a large long-range freighter. In the research and experimental field, there is considerable interest in short-take-off and vertical take-off possibilities and in advanced helicopter designs. In the civil field there has been considerable activity and many of our aircraft firms have applied their resources to the design and building of civil aircraft. A possible venture into the supersonic civil field is exercising many people's minds.

"I therefore think it fair to deduce that there is much challenging work ahead for the aircraft industry—though some reduction in production capacity from the expansion period of the Korean war is inevitable."

"The real significance of the industry to this country," continued Sir Claude, "is that it blazes the trail of advanced technical development. *Because* the specifications for aircraft and aero-engines are so exacting; *because* international competition for airline traffic is so intense, and *because* the ultimate limits of achievement in aeronautics are a challenge to anyone's imagination, the aircraft industry is continually reaching out into the unknown [for] technical knowledge which others can, and do, use."

OPEN FORUM

NOTHING could have been more symptomatic of the real issues facing the industry today than the tenor of prepared and spontaneous questions put to a panel consisting of Lord Douglas of Kirtleside (B.E.A.), Mr. Eric Turner (Blackburn), Mr. Peter Masefield (Bristol), Mr. Stanley Woodley (Vickers-Armstrongs), and ably chaired by Professor Richards of Southampton University. In viewing *The Importance of the Industry in the National Economy* almost all the questioners were concerned with developments in air transport, and the few exceptions dealt with matters of research. Dealing with the possibilities of Russian competition in the civil aircraft field, Lord Douglas said that he had been to Moscow and his impression was that Aeroflot would extend both across the Atlantic and across the world. They had got some very good aeroplanes including one—the Tu-114—that provided an answer to mass travel at cheap fares and would make an impact on civil air transport. Mr. Masefield commented that the Russians were still commercially naïve, but he was sure that they would learn very quickly. He did not see that they would be able to sell airliners to western countries for some time because of the difficulties of getting a United States C. of A.—it had been a big problem for British manufacturers and they had worked to American requirements. They might, he thought, undercut I.A.T.A. fares on the Atlantic and "bust the thing wide open."

The next question, which the chairman described as "put by somebody with his tongue in his cheek" was: In view of the low fares now being offered by charter operators would it be advantageous to abolish British scheduled operators completely? Lord Douglas commented that if the questioner had meant that more aircraft might be sold and cheaper fares introduced, he was wrong. To abolish scheduled airlines would have the opposite effect to that intended. Fewer new aeroplanes would be sold and the service to the public would be poorer. Mr. Dixie Keen thought that the real point of this question was "should the industry go whole-heartedly for aircraft that would provide the cheapest possible air travel" and he asked for comment on what Mr. Masefield had described in his spoken paper as "the great divide"—the choice between supersonics or low speed, low fare, mass travel.

Lord Douglas thought that the country should attempt to stay in both camps. It was desirable to make high speed aeroplanes, but we had *got* to stay in the business of mass travel.

Mr. Masefield said that we should progress in both directions. Tackled in the right way there were prospects of manufacturing aeroplanes that would get fares down to half the present costs, but the industry had got to be asked by an airline to design the right aeroplane. Fast aeroplanes would have to be big and they would inevitably be expensive to operate because their costs per aircraft-mile were high. Low costs per seat mile were of little consequence if aeroplanes had to operate with empty seats during the off-season. "I would like to agree," said Mr. Turner, "that the industry must develop air transport aircraft with the airlines."

The supplementary question was then asked "Suppose government support was given either in the direction of speed and prestige, or economy and profit. Which would the panel choose?"

Both Lord Douglas and Mr. Masefield opted for mass travel. Mr. Masefield added that large production runs came in the realm of low-cost travel; and that made possible the fulfilment of management responsibilities in keeping workers employed. But to achieve this there would have to be support by the government on an international scale. If we could offer a return ticket to New York for, say, £70, we would be in for a real tussle with the U.S., and would need government support.

The panel was next asked if they agreed with the mergers of aircraft firms. "They are complete nonsense," said Mr. Turner—"political claptrap by those who don't understand industrial organization." Amalgamations without large orders were nonsense, they meant less and less work for bigger and bigger units. The only size was the right size. If we got into the supersonic transport field, only then would successful collaboration and mergers come. Mr. Masefield agreed. He suggested that mergers were an attempt to avoid the unpleasant fact that some firms would have to go out of business. There was no sense in merging if there was less work to do. One idea was to make available more capital, but this was a misconception because manufacturing jobs in the industry were not attractive enough to raise public money. Working arrangements made to provide greater technical resources or more shop floor capacity could be sensible, but a wide amount of spread-out work was inefficient and led to higher overheads.

What structural re-arrangement within the industry would be needed, the panel was then asked, to tackle an M=3 aeroplane, and did the panel support the idea of an industry committee to work out our destiny?

"It is the men themselves that matter," commented Mr. Masefield. Informed, aggressive and knowledgeable men were wanted to decide the course the industry should take. Government nominees were not required. Private or nationalized, it did not seem to him to matter who owned the industry because it depended upon the people who really ran it. The time was ripe for a fundamental review of our objectives with a type of Brabazon-Cadman committee on the operational and industrial aspects of aviation.

Of the structure of the industry, Mr. Turner said that a supersonic transport could not be built with equal partnerships between firms. There must be a final design authority and the leader would be the biggest company.

Several questions were asked from the floor about the possibilities of manufacturing a profitable aeroplane to perform on stages of under 200 miles. The panel agreed that operations over these distances were extremely difficult to make profitable. The problem was inherent with short distances; handling costs and landing fees—however economical the aeroplane—occurred too frequently for an airline to make money.

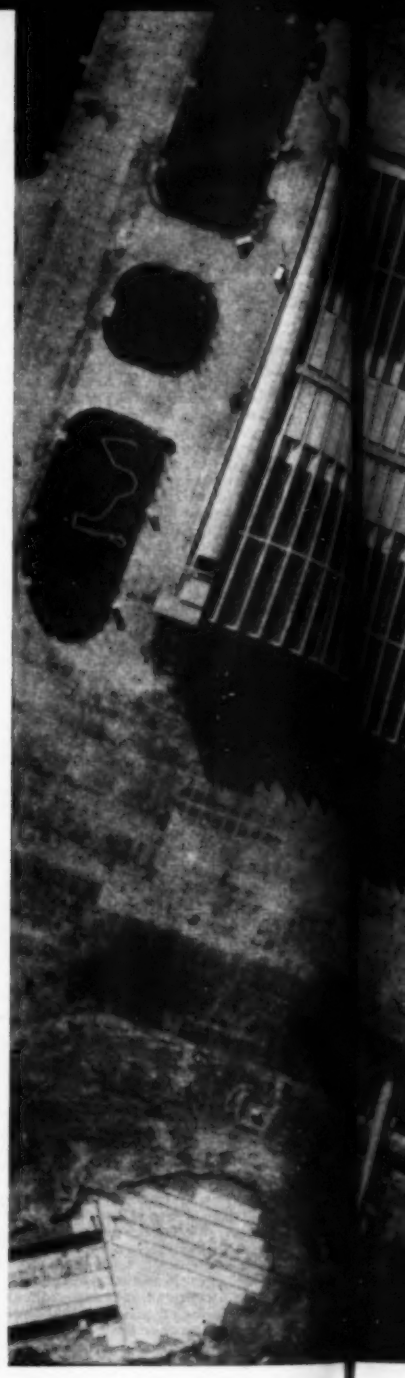
Very limited discussion was forthcoming from the question "Did the panel agree with the recommendations of the Supersonic Air Transport Committee?" It seemed clear that they did not; and the chairman commented that they were unanimous that any body set up to study the future course of the industry, must examine considerations of economics and prestige as well as what was technically feasible.

Of the several questions on research and associated questions that were asked, the panel agreed that more research was needed in methods of production. Mr. Woodley emphasized this point on several occasions. Mr. Masefield made the point that electrics were not good enough. They were unreliable and research in production engineering might help to make them simpler and better. Mr. Woodley also suggested that for production research laboratories were required, not just space on the shop floor.

Finally, and on a lighter note, the panel were asked the provocative question: "If your son wished to enter the aircraft industry would you advise him against it?" First off the mark was Lord Douglas, who commented that he had no son but he did have a daughter, and he intended that she should be the first woman captain in B.E.A. Mr. Turner and Mr. Woodley thought that if they had sons and they were unwise enough to be engineers, they could hardly get a better training, and Mr. Masefield summed-up by suggesting that aircraft engineering was, always had been, and always would be one for dedicated enthusiasts.

576-577 *FLIGHT*, 24 *April* 1959

An Imperial War Museum photograph of the original hand-operated A-type plate camera strapped to the fuselage of a B.E. 2C



From nearly nine miles up. An enlarged "detail" of London Airport: the B.O.A.C. engineering base photographed from 47,000ft by a Williamson F96 camera with 48in Wray lens

CAMERAS IN EVIDENCE

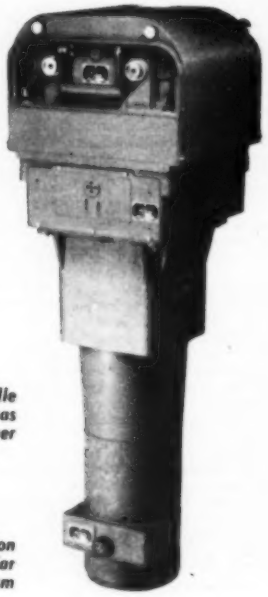
Britain's Newest Equipment for Service and Survey Use

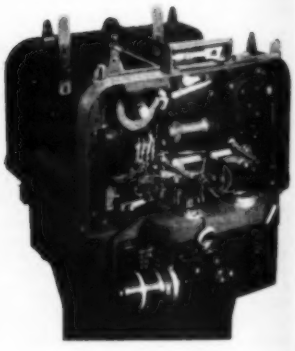
IT is a far cry from the original brass-bound mahogany A-type Thornton Pickard hand-operated air camera, suspended on the exterior of B.E. aircraft in the early part of the 1914-18 war, to the modern set-up of a battery of eleven Williamson F96 film cameras in a reconnaissance version of one of the V-bombers. For military purposes radar is now taking over much of the reconnaissance work; but it is difficult to believe that for sheer wealth of informative detail the air photograph will ever be completely superseded. If international inspection of atomic plants ever becomes fact, air photography will become big business.

In Britain, the Williamson Manufacturing Co. Ltd. are pioneers of the aerial film camera; their original F1 was in use in Mesopotamia and Palestine in the 1914-18 war, and their latest, the F117, is just going into service with Coastal Command. Now being produced by the company are the F49 survey camera, the F96 reconnaissance camera and the F117 universal air camera.

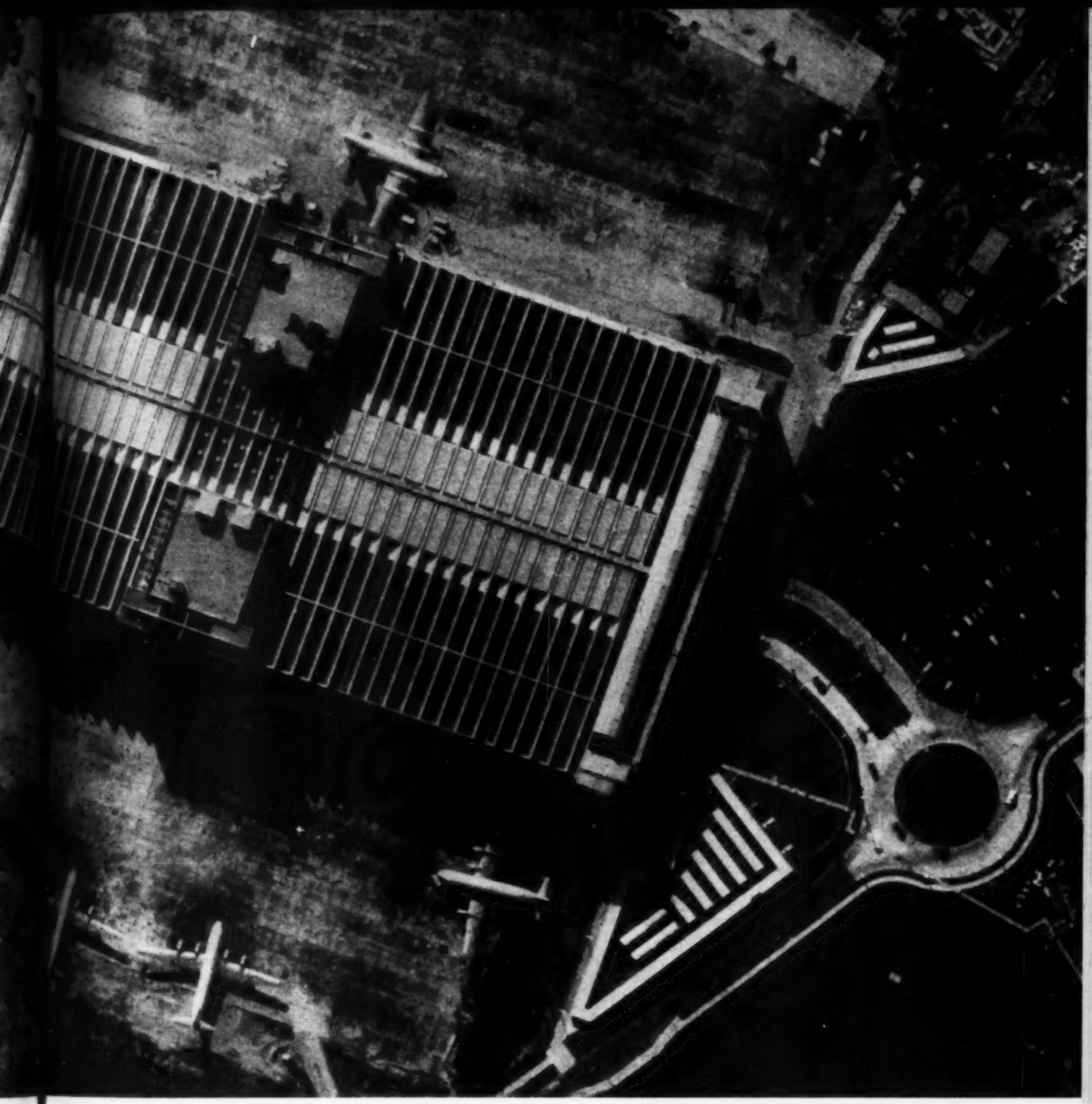
Many and diverse are the problems connected with photographic reconnaissance. Two

The F1 (above) was built by Williamson and used in the Middle East in 1916. It was the first air camera to use film, but was fully automatic; the slipstream windmill provided the power





(Right) As used to obtain the accompanying picture of London Airport, the Williamson F96, with 48in lens cone fitted. (Far right) Shutter setting, triggering and film shift mechanism



are critical. The high speeds of modern military aircraft make it necessary to shift the film and set the shutter in an extremely short space of time—in the F117 it is half a second; and the camera and all its appurtenances must function perfectly in tropical heat and stratospheric cold.

All testing of cameras for the Services is delegated to the makers, and for each F96 or F117 no fewer than 40 hours are devoted to the production of calibration charts and test reports. Flight trials, also, are a Williamson responsibility, although Fairey and Hunting do the actual flying for them.

The workshops in which these air cameras are produced are splendid examples of what such places should be. Not a trace of swarf or dust is to be seen on the floor—it all appears a trifle unreal to the visitor—and the optical shop is air-conditioned in order that dust, humidity or temperature shall not affect the precise work to be done there.

Type F96. The F96 camera is, in fact, a replacement for the F52, to operate under the conditions obtaining in the latest photo-reconnaissance aircraft. Among other requirements, the specification called for compensation for ground movement during the exposure, remotely controlled for any setting; minimum exposure interval; remote selection of lens aperture; increased capacity of film magazines; interchangeable lens cones; and flame-proofness.

The camera is electrically controlled and operated; camera control circuits operate on 28V D.C., and the main functioning motors can be either 28V or 120V D.C. Capacities of 1,000ft, 500ft and 250ft are available as magazines, which are attached to the camera by four spring-loaded corner bolts. The format of the camera is 9in × 9in, and each exposure records automatically the readings of two counters.

In the body are housed focal plane shutter, main gearbox and instruments. The shutter unit is removable, and three interchangeable shutter blinds are provided, giving exposures of 1/125, 1/250 and 1/500 sec. It is possible to double any of these exposures by remote control during flight.

Lens cones, housing lenses of 48in, 36in, 24in or 6in focal length, pick up on bolts on the underside of the body. Each has an iris-control unit which can be operated either manually or by

With St. Paul's Cathedral as the centre—part of a "fan" picture of London seen through the lens of an F96 camera

CAMERAS IN EVIDENCE . . .

remote control. The control system includes an intervalometer, giving a range between exposures of 1.8 sec to 60 sec, and also providing the usual pre-exposure warnings in order that the aircraft shall be level at the time of taking. There is also an I.M.C. unit, which is the transmitting portion of the image movement compensation servo mechanism.

Type F117. This camera, the latest to be produced, is also named the Universal Air Camera because of its wide adaptability to almost any type of aerial photography. It can be hand-held and hand-operated or hand-held and electrically operated. In its motorized version it can be installed as a vertical or oblique camera in a shockproof mounting. Electrically operated it can make exposures at the maximum rate of two per second. Electronic flash synchronization can be incorporated for low-level, low-light photography, and a "time" setting on the shutter makes the camera usable for night photography with flash bombs. The F117 is also capable of accurate calibration for survey or gunnery purposes. Instead of the more usual focal-plane blind, a between-lens shutter with metal blades is fitted. This should obviate the distortion inherent in the use of a focal-plane shutter in a moving camera but is not quite as efficient.

Speeds of 1/50, 1/100, 1/250 and 1/500 sec are provided, and are very accurate. In the prototype camera the actual figures obtained during a test of the shutter were: 1/50=1/54, 1/100=1/102, 1/200=1/195, 1/300=1/300 and 1/400—1/397 sec.

Format of the F117 is 4¼in×4¼in and the magazine, which is detachable, holds 50ft of film on standard international 5in spools. This is sufficient for 110 exposures. The standard lens is a 6in f/4.5 high-resolution Ross Xpres, and the weight of the complete camera, loaded with 50ft of film, is 15¼ lb. Its compact form and light weight make it very suitable for installation in small aircraft.

Williamson have for many years produced photogrammetric equipment, notably their Multiplex for air mapping; now they are extending their interests into the more commercial side of automatic enlargers and photographic processing machines. A large order for the latter has recently been received from the U.S.

JOHN YOXALL.

(Left) The hand-operated version of the F117 Universal Air Camera. In its electrically-operated version (right) the F117 is able to operate at the rate of two exposures per second

U.S. MISSILE TOUR (continued from page 566)

A full week lay ahead for delegates to the World Congress. Whether the congress would succeed in helping to bring the world closer to permanent peace by having people step inside an ICBM, by simulating the explosion of a nuclear bomb, and by its other and more obviously worthwhile activities, remained to be seen. As for us, the continuous background noise of the fruit machines, the click of dice and the chink of dollar chips faded into the distance as we left behind the incredible circus of a town that is Las Vegas. Thoughtfully, the U.S.A.F. had installed red obstruction lights at the tip of its Atlas and Thor-Able missiles.

Monday, April 13. Vandenberg Air Force Base, 170 miles north-west of Los Angeles, is the home of Strategic Air Command's 1st Missile Division, whose task is "to achieve, as soon as possible, an operational capability with ballistic missiles." It is also the base from which the Advanced Research Projects Agency's Discoverer satellite launchings are being made, and we were able to see and learn about both these activities during a four-day visit which began on the Monday.

"Gentlemen, the condition is now T minus 60 and counting." The speaker was Lt-Col. James Marquis, director of information, 1st Missile Division, and he was addressing a large crowd of journalists in the briefing room of the news centre at Vandenberg. The launch we were expecting was that of Discoverer 2, a heavier version of the first Discoverer launched into polar orbit from Vandenberg on February 28. As on that occasion, a Thor IRBM was to form the first stage of the launching vehicle, while the second-stage rocket would be a Bell Hustler (fuelled on this occasion and for the first time in a satellite launch by unsymmetrical dimethylhydrazine, with red fuming nitric acid as the oxidizer).

The satellite itself, which included the second-stage engine, was designed and built by the Missiles and Space Division of Lockheed Aircraft Corp., the prime contractor and system manager for the Discoverer programme. The orbiting weight was 1,600 lb—a 300 lb increase over Discoverer 1—for a gross weight at launch of 8,400 lb, an increase of 1,400 lb. Total weight of the first stage at launch was over 100,000 lb.

The objects of the satellite launching were described by William H. Godel, director of planning, A.R.P.A. The Discoverer series had no immediate military application, he said, but each test firing was more complex than its predecessor. Today's satellite would carry an environmental capsule equipped to measure and report on internal temperatures, pressurization and oxygen supply, in preparation for later flights which would involve animals, and three film packs would be used in an experiment designed to determine the nature of cosmic radiation.

Then came Mr. Godel's bombshell. "Finally, there is a remote possibility. The vehicle is equipped in such a way that an attempt at recovery *may* be made, although the odds against doing this the first time are about 1,000 to 1."

Recovery, if attempted, would be carried out as part of the following launch and flight sequence. Take-off from Vandenberg would be on a heading of 183 deg. After first-stage burnout the second-stage satellite is separated from the booster and coasts for a period. Radar at the U.S. Naval Missile Centre at Point Mugu, between Vandenberg and Los Angeles, tracks the second stage and gives the command for igniting the Bell engine.

The satellite's guidance and control system includes an inertial reference package, an infra-red scanning device, a pneumatic jet control system and a hydraulic control system. After separation and before ignition of the second stage the satellite is programmed into a horizontal position by means of the inertial package and the pneumatic jet control system, aided by the infra-red scanner which detects the horizon.

Upon ignition the hydraulic control system takes over from the pneumatic system, gimballing the rocket engine to maintain the satellite in a horizontal position during orbital injection. The infra-red horizon scanner continues to operate, relaying corrections to the second-stage guidance system. After second-stage cutoff the pneumatic jet control system resumes operation, with high-pressure helium being metered to a series of positioning jets.

The most interesting phase would of course be that of re-entry, with the possible attempt to recover the 195 lb re-entry body (the remainder of the payload comprises 245 lb of communications equipment, telemetry and instrumentation). All being well the recovery attempt might be made by C-119 aircraft of 6593rd Test Squadron, U.S.A.F., based in Hawaii and supported by naval units.

After the satellite had been stabilized in the appropriate position, the re-entry section would be separated by means of explosive bolts and springs. A retro-rocket would slow the vehicle to re-entry velocity and a deceleration switch would release a parachute at a suitable altitude. The main component of the re-entry vehicle is the recovery capsule (27in long × 33in diameter) weighing approximately 160 lb.

Eight C-119s patrolling the recovery area near Hawaii would home on the radio beacon attached to the recovery package. A trapeze apparatus suspended from the rear of each aircraft would be used in an attempt to "snatch" the descending parachute, which could then be reeled into the aircraft. If this proved unsuccessful a navy destroyer would be vectored in by aircraft to effect a sea recovery of the package.

Launch of Discoverer 2 at Vandenberg on April 13

This, then, was the intriguing possibility on our minds as we were driven, in a long caravan of vehicles led by an Air Police truck with flashing red beacon, out to the news observation post from where we would watch the firing. Here refreshments were being dispensed from a coffee van, mobile news cars from local radio stations KCOY at Santa Maria and KNEZ at Lompoc were in position, and a command-post truck was manned by earphoned U.S.A.F. officers. The Press corps quickly settled down, swarming over the wooden grandstand with typewriters at the ready and over the long tables in front which carried 13 telephones. Photographers set up their tripods—and their telescope-like cameras, for we were 10,000ft from the launch point, and the longer the lens the better.

Looking across the flat scrub towards the slightly undulating line of the coast, the white upper stage of the rocket could be seen above the crest of one of the sand-dunes. "Gentlemen. It is now T minus 30, and counting"—the time was 10.48. As William Godel of A.R.P.A. was answering the questions of a group of Los Angeles pressmen—"Yes, you could call the environmental capsule a life-support system . . ." another journalist was phoning his preliminary story to his paper—"The decision on whether recovery will be attempted this shot will be made after intial data are analysed. . . ."

The first delay came at 10.53 when, at T minus 20, the long-stalked loudspeakers reported that we were holding for an estimated 60 minutes. At 11.20 a train headed for San Francisco moved across between us and the dunes, closely shepherded by an S-55 helicopter whose job it was to keep the site clear (a Cessna L-27A was also used for this). By 11.30 two of the watching U.S.A.F. N.C.O.s had begun to practise golf shots in the brush, and Station KMPC was interviewing Mr. Godel (having already interviewed the B.B.C. correspondent in our group and extracted his views on the United Kingdom Thor bases, missiles and defence in general, and the impact of Las Vegas on the British Press).

Because Vandenberg's own radar tracking facilities were not yet complete, it was necessary to use visual tracking of the rocket in

U.S. MISSILE TOUR . . .

First launch of Thor by a Royal Air Force crew—the dramatic moment at Vandenberg A.F.B. on April 16

the initial stages. Thus we had to wait through a series of "weather holds" while the sun burned off the low cloud. At 12.45 the count-down continued from T minus 20, only to be held again at T minus 11. After it had been resumed the excitement mounted as a "planned technical hold" at T minus 2½ was used to make the final check that the area was clear, and as the time was called in seconds, not minutes.

Then it was T minus five seconds, and then zero. A puff of yellow-grey smoke floated up over the launch point, and then we saw the slim length of the rocket, rising incredibly slowly at first, and balanced on a fierce orange jet. The noise hit us, growing and seeming to fill the whole sky with a deep roar as Discoverer accelerated steadily upwards and curved over to the south. As it passed across the sun a short vapour trail appeared, and a second, thinner trail was scrawled against the upper sky before the rocket finally vanished, some 2 min after launching.

Two hours later, at a further Press briefing, U.S.A.F. and A.R.P.A. officials expressed themselves well pleased with the firing, which had resulted in an orbit very close to that intended. The Discoverer project officer who had controlled the launch was Capt. Robert Roy. Whether or not the re-entry capsule was separated and recovered, the estimated orbital life of the remainder of the satellite was about 30 days. The general schedule for future Discoverer launchings was for one per month, Mr. Godel stated, and the first Atlas to be used in this programme would be fired from Cape Canaveral.

This was the opening day of the World Congress of Flight at Las Vegas, and was marked by the speed record set up by Miss Jerrie Cobb in an Aero Commander. Flying over a 2,000 km course she logged an average speed of 226.15 m.p.h.

On **Tuesday, April 14,** A.R.P.A. announced that it would not be possible to recover Discoverer 2 in the manner previously described, because of a faulty timing device in the satellite. The intention had been to separate the capsule automatically on its 17th orbit, but the timing malfunction meant that it would be ejected north of the proposed area of recovery.

At Vandenberg, the planned first firing of a Thor by an R.A.F. crew was postponed, initially because of technical trouble and finally because of the weather. The key men in the crew were to be S/L. Peter G. Coulson, launch control officer; Master Pilot Maurice H. Sloan, launch monitor console operator; and Chief Technician Roy M. Carpenter, missile maintenance technician.

The respective duties of these men were as follows. The launch control officer operates the launch control console, and is responsible for observing correct phase sequencing and initiating holds as appropriate. The launch monitor console operator monitors detailed phase sequencing and 30 malfunction indicators. He is responsible for data flow analysis of any malfunction and he advises the l.c.o. accordingly. When directed by the l.c.o., he imposes technical holds and overrides malfunctions when appropriate; and he monitors the continuous status, target selection and guidance alignment panel.

The missile maintenance technician assists in the "T minus one day" checks (all settings and adjustments prior to "T minus 15 min" state of readiness for all ground support equipment). During the actual countdown he is on a standby basis for the repair of any malfunction in the weapon system.

The R.A.F. Thor launch would be in a sense a graduation exercise for the R.A.F. students, whose training as crews at Vandenberg had been carried out by the 392nd Missile Training Squadron of the 704th Strategic Missile Wing, which is itself a unit of the 1st Missile Division. Two other training squadrons, the 576th and the 395th, deal similarly with Atlas and Titan training and also come under the 704th Wing. The 1st Missile Division began life as a unit of Air Research and Development Command on April 15, 1957, and was transferred to Strategic Air Command on January 1, 1958.

Technical and weather holds at Vandenberg on **Wednesday, April 15,** again forced a postponement of the R.A.F. Thor launch. Planned originally for 11 a.m., the final postponement "for technical reasons" was announced at 4.45 p.m. In the Las Vegas area, the 2½-hour firepower demonstration at Indian Springs gunnery range brought speed, noise, smoke and flame to the World Congress of Flight, and it was announced that Capt. George A. Edwards Jr. in a McDonnell Voodoo had set up a new record of 816.28 m.p.h. over a 500 km closed course.

The Discoverer 2 capsule was reported by the U.S.A.F. to have fallen to Earth in the north polar region. Both visual sightings and radio signals, it was stated, had indicated that the capsule had been ejected on the satellite's 17th orbit.

The technical snags which had dogged the previous two days' attempts to fire the R.A.F. Thor had been traced and corrected by **Thursday, April 16,** when an almost completely straightforward countdown was accomplished (under operational conditions, the missile could have been fired on the first day).

Among those watching the launch were A.V-M. W. Sheen, Commander of R.A.F. Staff, British Joint Services Mission, Washington, and A.V-M. G. A. (Gus) Walker, commanding the R.A.F. Vulcan flight at the World Congress of Flight. At T minus 14 the missile was raised into the vertical position and its upper section could be seen over the sand dunes which surrounded the launch site. The final range safety check was made during a planned technical hold at T minus 4, and at the scheduled time of 12.46 (8.46 p.m. G.M.T.) the Thor got away to a good launch, disappearing briefly into cloud before continuing almost vertically, chalking a white vapour trail against the upper blue sky.

This was a great day for the Royal Air Force, said G/C. R. T. Frogley, senior R.A.F. officer at Vandenberg, when we met the R.A.F. crew later that afternoon. Maj-Gen. David Wade, commander of the 1st Missile Division, added his congratulations on a successful shot. G/C. Frogley said that Thor had now taken its place in the R.A.F. armoury of weapons. The three days' operation, involving the detection and rectification of malfunctions, had been a time of strain on all concerned but had provided the best possible training. A fourth crew-member in the launch, as well as those whose names had been announced earlier, had been Master Pilot A. E. Cover, who had aligned the guidance section of the missile. S/L. Coulson showed a personal souvenir—the key with which he had switched on the final countdown sequence. The time taken, he said, had been within the target period laid down. [Last weekend it was announced that the Thor had achieved its full design range.—Ed.]

(To be concluded)

On the left are seen the successful crew—from the left, C/Tech. R. M. Carpenter, M. Plt. M. H. Sloan and S/L. P. G. Coulson—with G/C. R. T. Frogley, senior R.A.F. officer in charge of Thor trainees, in front on the left. S/L. Coulson is holding the fateful key; on the right he is seen about to turn it in the launch control console

Straight and Level

IN the present state of the art the launching of a military ballistic missile is in many respects comparable with that of a satellite or space probe. Things may or may not go according to plan, and it is always a good idea to shoot first and shout afterwards.

For this reason it is particularly satisfactory that the R.A.F. team which recently graduated on the WS-315A Thor IRBM system got over the final hurdle with a superb launching of their own white-painted missile bearing the R.A.F. roundel.

Though most of us hate ballistic missiles, and would be glad to see them abolished, one has only to think for a moment of what failure at the end of the count-down would have meant to the morale of S/L. Coulson and his men to sense the psychological importance of their success. Congratulations to Bomber Command.

● I winced when I got my copy of *The Story of the Air League*, the League's jubilee book now on sale to the public at a shilling. The cover is a pictorial patchwork representing, I suppose, modern British aircraft. Of thirteen pictures no fewer than three show Bristol 170s (honestly), and three more are of Britannias. So Bristol scoop about half the pool. Three others depict the now-defunct Fairey Ultra-Light, and the Rotodyne gets one. Blackburn, Westland and Gloster likewise get one apiece; but it seems that we shall have to wait another 50 years for Vickers, Hawker, Avro, Handley Page, English Electric, Armstrong Whitworth, de Havilland and the other small fry to get a look in.

But perhaps one shouldn't carp about people on their birthdays; and after all it's the innards of a book that really matter. So I flicked aside the offending cover all open-minded and forgiving. Only when a photograph of a model of Santos Dumont's *Demoiselle* was presented to me on the very first page captioned "British Army Aeroplane No. 1 flown by S. F. Cody at Laffans Plain" did I reach for my pen. Because this book is supposed to educate the British public.

Sorry, Air League. Happy birthday anyway.

● After one year's operation, average utilization of B.O.A.C.'s Britannia 312s was 3½ hr per day. After one *week's* operation, average utilization of Ansett-A.N.A.'s Electra was more than 11 hr per day.

● The popular new supersonic airliner poker-game has reached the bidding stage. The time for bluff is past and hands are being called.

No money has yet been exchanged, but the chips are down and the stakes are very high. The M-pips on the cards, in digits and decimals, are numbered from one to five; the highest numbers are trumps.

Now the first hand is shown. A modest but considered play—in which *two* cards have been placed on the table. The pips show 1.2 and 2.0, and the combined stake—representing a £200m fortune—is as high as the player can go.

But it is clear from my seat beside the table that the M=2 card is going to be trumped—by the next player to show his hand.

● *"The growth in labour productivity must always exceed the increase in average wages. The proportion of wages to total cost must steadily decrease."*

Tell *that* to the London Airport shop stewards and you'd get trampled to death by workers rushing out to hold a mass meeting.

Who said it, anyway? The management of Aeroflot—in a warning to workers about the recent poor profitability record. The doctrine was described as "one of the basic tenets of Marxist-Leninist teaching."

● *"It verges on the ridiculous here in the spring of 1959, with at least three of the 12 scheduled airlines in the country [America] in severe credit difficulties and three of the remaining nine in a financial bind, that after months and months the general fare investigation seems but little closer to conclusion."*—Earl D. Johnson, executive vice-president of General Dynamics Corporation.

This remark—the background to which is that the U.S. airlines want to increase their fares—poses two interesting questions.

First, is it seemly and right for aircraft manufacturers to advocate increases in air fares as a means of improving the market for their products?

Second, if it *is* right, does it make sense to advocate fare *increases*? With great respect to Mr. Johnson (who is a former president of the U.S. Air Transport Association), I suggest that his factories will be fuller if air fares are reduced, not increased.

● Another quote from the world citadel of competition:—

"The spreading cancer of unnecessary multiple competition continues to gnaw at the vitals of airline economics"—Mr. Todd G. Cole, Delta Air Lines.

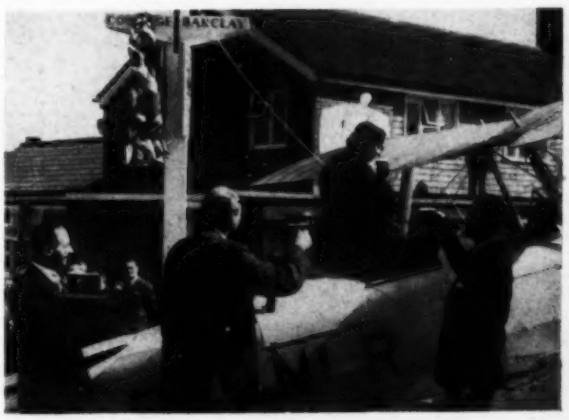
This may be true. But who is to blame for the alleged malignancy, if not the airlines themselves? No one ever *directs* them to apply for a new route. Will Delta advocate that their next route-application be turned down, I wonder?

● There was an epic touch in the simultaneous announcements last week of selection of the first seven candidates for space missions and the retirement of Tim Wood as Blackburn's chief test pilot. Something piquant, too; because whereas the space-agers hold bachelor degrees, or equivalent, in the physical sciences or engineering, and will be launched only "at the peak of physical and psychological readiness," Tim used to manage a pub for his mother-in-law as a sideline to piling up 14,000-odd hours' flying, and attributes his fitness to "too little exercise and too much drinking and smoking."

I am not being so flippant as you might think; because the deputy director of the U.S. National Aeronautics and Space Administration has said that the first space mission should be "at least as safe as the first flights of a new high-performance airplane." And if Tim is still man enough to fly the NA.39 chase Meteor, he is not *so* far off being in line for a modern prototype—aeroplane or elementary spaceship.

● Anyway, Tim deserves a place among the immortals for the crack he made to his co-pilot on the first flight of the Beverley. "My side," he observed, "is airborne. Is yours?"

ROGER BACON



I never thought to see Col. R. L. (Mossie) Preston, secretary-general of the Royal Aero Club, not only quaffing an alcoholic beverage whilst at the controls of a Tiger Moth, but actually doing so outside a pub—having just taxied (more or less) his aeroplane along the Rochester-Canterbury road. For an explanation—I think one is required—see news item overleaf

Sport and Business

"MIKE'S MUG," a pint tankard which the Steering Wheel Club was to have presented to the late Mike Hawthorn, has been offered to the Royal Aero Club. It is intended as a gesture of recognition of the close connection between the two bodies, as symbolized by Mike Hawthorn's frequent use of his private aircraft on business. In accepting the gift the Royal Aero Club have decided that it is to be awarded annually to "the pilot considered to have demonstrated most convincingly, by his flying, the utility of light aircraft for business and executive as well as for private purposes."

CONVERGING ON MOSCOW for the general conference of the Fédération Aéronautique Internationale between May 25 and June 2 will be nearly 200 representatives of aero clubs and associations around the world. Representatives of Britain, Belgium, the United States and Turkey are among those who have accepted invitations and Mrs. Jacqueline Cochran, president of the Federation, has promised to fly to Moscow in her own aircraft. Britain is to be represented by Col. Preston and a team from the Royal Aero Club.

YORKSHIRE AEROPLANE CLUB is in the process of being re-formed at Leeds/Bradford Airport, Yeadon, its home for ten years before the war. Arnold Wilson and Ronald Braime, pillars of private flying in the West Riding for over thirty years, have taken over the equipment, assets, goodwill and, they hope, the members of the former Yeadon Aero Club. The renascent club start flying at the end of April.

EAST BUCKS FLYING CLUB is moving from Denham to Reading on May 1 to reform the Reading Flying Club at Woodley Aerodrome. The move has been made possible by the support of Handley Page and the co-operation of Western Manufacturing Ltd. Nightscale Aircraft Services will continue to operate the club with an initial fleet of two Austers and a Tiger Moth. Chief flying instructor is G/C. G. V. Carey, assisted by Mr. J. Richardson.

A SYNDICATE is to be formed to purchase a Garland-Bianchi Linnet. It will be based at Biggin Hill and, assuming reasonable utilization, members should be able to fly for about £2 15s an hour. Details from Mr. J. Fleming, 26 Barclay Road, Croydon, Surrey.

INTEREST IN BENSEN AUTOGYROS in this country is increasing. In addition to the Gyro-Gliders previously mentioned (*Flight*, February 6 and April 3) there are numerous home-built examples in various stages of construction and several powered versions, known as Gyro-Copters, are nearing completion in the London area. The airframe is small and simple enough to be constructed in a lock-up with normal "do-it-yourself" tools and with little outside help, although time and care are needed.

The most suitable engine available, and that recommended by Bensen, is the four-cylinder two-stroke McCulloch of 100 cu in capacity. The engine produces an output of about 75 b.h.p. for a weight of 75 lb. Over 32,000 of these engines have been made for target aircraft and are available on the American surplus market. They must, however, be modified if longevity is to be achieved.

The power output is excessive for the basic single-seater Gyro-Copter, but it allows great scope for development as well as providing a rate of climb approaching 2,000ft/min. Fitted with power transmission to the rotor, for starting, the machine should take off in the length of a tennis court at an airspeed of about 20 m.p.h. It will descend into a smaller area at an airspeed of 7 m.p.h., and in common with most autogyros it can descend vertically with some loss of control.

ELSTREE FLYING CLUB have introduced bookings-appointment postcards, to be sent to every member. Requests for bookings are posted back to the club who tick-off those that can be accepted and return the card to the member as a reminder. Over 70 firm enquiries have been received for the deferred-payment flying scheme and the number of applications that can be accepted may have to be restricted. A new instructor, Mr. Gordon Bedggood, has joined the staff and six full-time instructors will be now available for the summer season.

Plans for setting-up a new Derby Air Centre (to replace the former Derby Aero Club) under administrative control from Elstree are now virtually complete. An Auster Alpha and a Hawk from Elstree will be posted to Derby for the start of operations, but during the year the Hawk will be replaced by a Chipmunk.

EXECUTIVE AIRCRAFT on view at the Shackleton Sales Weekend at Kidlington, Oxford (today, tomorrow and Sunday, April 24-26) should represent a wide cross-section of modern U.S. and European types.

The American contribution will include a Beech Twin Bonanza, Cessna 310 and a full range of Pipers—Comanche, Apache, Super Cub and Tri-Pacer. Coming from Germany is the Rhein-Flugzeugbau R.W.3 Multoplan, from Belgium the Tipsy Nipper and from Italy the Piaggio P.136 amphibian, P.166 executive and the sleek Aeromere Falco—as exciting a collection of business aircraft as has ever been assembled in the British Isles. W. S. Shackleton Ltd. say that, subject to their being able to obtain import licences, orders can be accepted for any of the foreign machines on show, and in this connection the attitude of the Board of Trade is reported to be easier than was formerly the case.

New aircraft from British manufacturers will also be shown, notably the Auster Workmaster, Garland-Bianchi Linnet and Thruxton Jackaroo. Rollasons will be exhibiting rebuilt Tiger Moths and new Jodels and Turbulents and de Havilland their demonstration Dove.

CONSTRUCTION of the Meindl light twin by Panker A.G. in Vienna, first mentioned in *Flight* of February 14 last year, is now apparently well advanced. Powered by two Lycoming O-290-D engines giving 140 h.p. each, the Meindl M-222 seats four and is aerobatic with two occupants. The laminar-flow wing is made of wood while the fuselage is in welded steel tube with light-alloy skin forward, laminated plastic aft and a wooden tail. All fuel is carried in tip-tanks, as in the Cessna 310. Undercarriage springing is by a patented torque-rod system.

Span and length are respectively 36ft 2in and 28ft 2in; gross and empty weights, 3,200 lb and 1,950 lb; maximum, cruising and landing speeds are respectively 187 m.p.h., 168 m.p.h. and 70 m.p.h.; single-engined ceiling and endurance are 7,900ft and 5 hr.

FIRST PRODUCTION MODEL of the Bréguet 905 Fauvette sailplane is due to be delivered to the British pilot Tony Goodhart this month. A series of 100 Fauvettes is to be produced, at a rate of five per month beginning in May, and orders for over 20 have already been received. It is possible that Cdr. Goodhart's Fauvette may participate in the British national gliding championships at Lasham next month.

Flying over the new public house "The Tiger Moth," near Rochester Airport, are S/L. F. Holt and Col. R. L. Preston, secretary-general of the Royal Aero Club. After taxying (by manpower) along the main Maidstone-Chatham road to the front of the inn, Col. Preston unveiled the signboard and dealt with the first pint

RETROSPECT

From "Flight" of April 24, 1909

Curiosities at the Aero Show: It is quite common to find at exhibitions, and the Aero Show at Olympia proved no exception to the rule, that the general public are caused to display a greater temporary interest in what may be described as the curiosities than they do in those which should have a greater *prima facie* claim upon their attention... The application of an aeroplane to an ordinary push-pedal bicycle is the ostensible purpose of the "Cycloplane," which also serves the supplementary and possibly not less useful object of providing a permanent sunshade and umbrella over the rider: it might also be regarded as a place of refuge from the unexpected attacks of the fierce-looking French kite called the "Aiglo-plan," if such devices as these should ever become popular.

Correspondence

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns. Names and addresses of writers, not for publication in detail, must in all cases accompany letters.

Secret Unfrozen

THE interesting letter from Mr. George Miles on arrester-nets [April 10] needs to be answered, if only to reply to the gentle implication that the officials in M.A.P. were a crowd of clots not to accept his brilliant idea and pursue it. May I shed some light on this matter—and relieve George Miles and his co-workers of what I know has been a sore point with them for years?

At the material time—and this is the most important factor—the idea was submitted to, eventually, Cdr. Stacey Colls, under whom were Lt-Cdr. Douglas Pelly and myself. We all thought the idea excellent: but the fact to be faced was that the Staff at the time were considering operations in the Far North, and this fact was Very Secret and could not be passed to George Miles, etc. Now, the Miles arrester net worked admirably in temperate climates, but, on miniature tests we made secretly it was shown to our satisfaction (and regret) that the net iced-up and became an impossible proposition where icing was a certainty. So, without saying why, this proposal was rejected.

I can only add that we on the inside felt tremendous sympathy with George, but that some of this was vitiated when he wrote a long screed of complaint at the rejection; and this, again for security reasons, we could not answer appropriately. May we hope we are now forgiven for our apparent clottishness?

London, W.1. B. J. HURREN.

Nocturnal Jet Noise

WITH regard to the "waking hours" mentioned in "Air Commerce" (p. 503, *Flight*, April 10) I would very much like to know who decides on the limits of these so-called waking hours. It seems obvious he does not live in the vicinity of London Airport.

I'm sure parents of young children will agree with me that 10.15 p.m. should be called a sleeping hour, as also should 7.15 a.m. on a Sunday.

One of the jets leaves every night at 10.15 and a Boeing 707 was seen to go in to land at 7.15 on a Sunday morning.

Twickenham, Middx. S. A. WILKINS.

Research and the Librarian

WITH reference to your editorial "A Matter of Survival" (April 10), may I point out that the expression "Aeronautical research" should be preceded by "original"?

To ensure that research *is* original one must make literature searches. To make efficient literature searches one must have men trained in the work, i.e., librarians.

Many firms have librarians. Few firms realize how valuable those librarians can be. They are not a luxury. They are an indispensable necessity. There are not many employees in the aircraft industry who can save more money than they cost—whatever they cost.

London, W.1. F. H. SMITH,
Chairman, ASLIB Aero Group.

Thunder and Lightning?

AT approximately 10.35 a.m. on Friday, April 10, the grand-daddy of all supersonic bangs smote the southern half of this island. I have heard a number, but this outclassed the lot. The ground literally shook!

After the impact, a thin whine of a very fast aircraft was heard going out eastward. All this prompted me to put my shirt on a certain Driver Airframe (fast), Beamont type.

Port Erin, Isle of Man. D. G. DOBSON.

The von Richthofen Book

IN "The Aeronautical Bookshelf" (p. 700, *Flight*, October 31, 1958) there appeared a review of our book *Von Richthofen and the Flying Circus*. We are not here concerned with the opinions of your reviewer—he is, of course, entitled to them—but we *are* interested in the *basis* for them. This review contained allegations which reflect on the literary integrity of the compilers, Herr H. J. Nowarra and Major K. S. Brown, U.S.A.F. Worse, your reviewer gravely misrepresented his own "authority" for both his opinions and these allegations.

The delay in responding some months after publication of the review is due to exhaustive researches we have made to ascertain the real facts in regard to your reviewer's ability to review our book. This involved letters to and from America and Germany, and tracing several German fighter pilots who were personally associated with Baron von Richthofen. Necessarily this took some time. The results of our researches follow.

(1) Your reviewer said: "As aviation history or as a story of a famous fighting unit, the main text is sadly disappointing . . . it soon becomes apparent that here is little more than a collector's effort based upon careful perusal of all available literature; and much of that literature one knows to be clearly apocryphal . . . A good deal of the text consists of combat stories—clearly not written from first-hand knowledge or war reports . . ."

The facts are that the whole of the main text, and in particular the whole of the reports of Baron von Richthofen's 80 combat victories, were written-up by our editor Mr. Bruce Robertson, drawing upon translations of the Baron's own combat reports, cross-checked with the appropriate official British combat and casualty reports. (These are available on application to the Imperial War Museum and the Air Historical Branch of the Air Ministry, respectively.) Further additional information was, of course, provided from the really extensive records of the two compilers.

(2) Your reviewer was not present at any of these combats involving 128 aircrew, of whom 99 were killed; and of the remaining 29, the majority were wounded and/or taken prisoner of war. Few can survive to-day; but of them, 2nd Lt. H. J. Sparks (P.o.W., wounded), having read our book, wrote in to say "I must congratulate all concerned on its detailed accounts. I happen to be the gunner of the machine that the Baron claimed as his 64th, and I must say that the report of the scrap is very exact." Von Richthofen's 80th victim, 2nd Lt. D. G. Lewis (P.o.W., wounded) was traced to Southern Rhodesia. Having read the book he wrote that our account of his fight was correct, adding: "What a beautiful publication it is . . . I had completely forgotten the number of the machine in which I was shot down, and am pleased to know what it was . . . Congratulations on the book."

Five members of the "Flying Circus" were traced and to each was sent a copy of our book. They replied as follows:—

(a) Lt. Carl Galetschky (joined *Jasta 6*, 18.8.17, two victories)—"I have known Manfred von Richthofen personally and I think that the book is a most remarkable publication; as truthful as possible and to the point." (b) Lt. G. W. Groos (joined *Jasta 11*, 26.6.17, six victories)—"The book has met with my unreserved approval both in regard to its contents and its exemplary presentation. In my opinion the authors have succeeded in giving an unprejudiced absolutely correct and truthful picture of Captain von Richthofen and of the fighter pilots of the first World War." (c) V.f.w. Gabriel (joined *Jasta 11*, 15.4.18, eleven victories)—"I liked all parts of the book very much, and indeed it agrees entirely with the historical facts." (d) Lt. F. Lubbert (*Jasta 11*—"I have read some important chapters and these correspond to the facts in every way . . . Further, the book would absolutely be in conformity with the taste of the brothers of Richthofen and I consider this to be of importance and of value."

(3) Your reviewer claims: "To one who was acquainted with the book's subject and his times . . . when the present writer last saw von Richthofen, only a day before his end . . ."

Your reviewer was German born on April 15, 1897. He was thus six days past his 21st birthday on the day von Richthofen was killed. As throughout the two-year period of work involved in compiling, writing and producing our book not once did we come across your reviewer's name; the accuracy of the above claims was immediately called in question. None of the four German pilots we quote had ever heard of him. The final word comes from Air Force General (retired) Karl Bodenschatz, who joined *Jagdgeschwader Nr. I* on 2.7.17 as adjutant to von Richthofen, and who held this position without a break until after the latter's death; he says: "My enquiries so far made of several old Richthofen pilots have shown that none of them knows the re-

FORTHCOMING EVENTS

April 24-26. Shackleton Sales Weekend, Kidlington.
April 28-30. French and British Institutes of Navigation: Symposium on Automatic Navigation, Paris.
May 2. British Interplanetary Society: "Inertial Guidance and its Application to Astronautics," by D. J. Cashmore.
May 2. Aerial At Home, Woburn Park.
May 4-14. I.A.T.A. Technical Conference, Berkeley, Calif.
May 5. R.Ae.S.: "The Potential Use of Aircraft for Agricultural Purposes," by R. H. Scott.
May 8. Helicopter Association: "Helicopter Noise Suppression," by H. B. Irving.
May 9. U.S.A.F. At Home: Wethersfield.
May 9-18. British National Gliding Championships, Lasham Gliding Centre, Hants.
May 14. R.Ae.S.: 47th Wilbur Wright Memorial Lecture, "Managing Aviation Technologies," by C. J. McCarthy.
May 16. U.S.A.F. At Homes: Bentwater, Sculthorpe and Alconbury.
May 18. S.S.A.F.A. Display, Leeds-Bradford Airport, Yeadon.
June 12-21. Paris Aero Show.
Sept. 7-13. S.B.A.C. Display and Exhibition, Farnborough.
R.Ae.S. Branch Fixtures (to April 29): April 29, *Christchurch*, a.g.m.; *Weybridge*, a.g.m.

CORRESPONDENCE . . .

The two photographs referred to below by Mr. D. A. Russell. On the left von Richthofen is seen using a step-ladder to reach his cockpit; at right, Oberursel engine markings (Imperial War Museum)

viewer. I myself likewise cannot remember him. During the days before April 21, 1918 (date on which von Richthofen was killed) I was at the front with the squadron. During that period I neither made the reviewer's acquaintance nor did I see him. He cannot therefore have talked to Richthofen, as I regularly used to be present at such conversations."

(4) Your reviewer complains that the authors "miss the point that von Richthofen, as well as Boelcke, directly endeavoured to influence development and selection of [the] equipment" [for the "Flying Circus"].

We quote from Anthony Fokker's book *Flying Dutchman* (p. 201)—"Richthofen knew little or nothing about the technical difficulties of air planes. Unlike Boelcke and Immelmann, he was not even interested, except as it was necessary for him to know for his own safety and development."

(5) Your reviewer says that when he last saw von Richthofen "only a day or two before his end, he was happily exercising his new mount [D VII] displaying it with pride around neighbouring airfields." Von Richthofen shot down his 77th and 78th victims on April 7, 1917. For the next several days bad weather prevailed and prevented flying. Then there followed the move to *Jasta 11* to Cappy. Here again there was bad weather, and as is recounted on page 103 of our book, "during the days that proved to be his last he was kept much to his quarters writing a treatise on air fighting, bringing up to date the dicta of Boelcke in the light of recent experiences." The bad weather continued until the 19th. On the 20th von Richthofen shot down his 79th and 80th victims. On the 21st he was killed. On p. 198 of his book Anthony Fokker says "for three weeks I lived with the Richthofen *Jagdgstaffel* located at the time on the Ypres front . . . this was only a short time before Richthofen was killed, when he commanded the Circus and had a great deal of executive duty to attend to as well as his daily fighting. Secretaries raced about and orderlies came and went all day."

Your readers may choose between (a) the statements of Karl Bodenschatz and Anthony Fokker—both of whom were in daily intimate contact with von Richthofen in the two-to-three-week period prior to his death—and (b) this "claim" by your reviewer, who was nowhere near the Front, less still in contact with von Richthofen, at *any* time.

(6) Your reviewer states that "Oberursel-built rotary engines were not fitted to Fokker Dr. I triplanes." This statement is entirely unfounded. It implies directly that the engine (a photograph of which appears on p. 117 of our book) and which for the past 40 years has been on exhibition at the Imperial War Museum, has been incorrectly labelled by the museum authorities.

It is categorically stated in the official report of the investigating Allied Control Commission—*Rapport Technique Commission Interailiée de Controle Aeronautique en Allemagne*—that Oberursel engines *were* fitted to Fokker Dr. I triplanes. Anyone may examine the engine at the I.W.M.; having done so, we report that (a) it is stamped in several places with the trade mark letters MO. These stand for "Motorenfabrik Oberursel A.G." (b) Such parts as the crankcase, conrods, and even pistons reveal them to be marked with the letter "U" embracing a figure 5, being an inspector's stamp number. (See stampings to the left and right of the Engine Number 2478 in the accompanying photograph—courtesy of the I.W.M.) Note: "U" is the *Flugzeugmeisterie* Code letter for Oberursel. "O" would seem to be a more appropriate letter, but it had already been allocated to Opel.

(7) Your reviewer says: "And to let fighter pilots mount to their cockpits by wooden step-ladders at least gives credit to the author's inventiveness." On behalf of Messrs. Nowarra and Brown we protest at the reference to their alleged "inventiveness". . . an indirect way of suggesting that they were lying . . . your readers will no doubt be interested in the accompanying photograph, which shows none other than Baron von Richthofen *himself* at the top of a step-ladder, about to enter or leave an Albatross D.III . . .

(8) At our invitation, your reviewer visited us at Letchworth early this year. All three directors of this company were present at what was throughout a friendly discussion. When asked what was his rank in the German Air Service, and to which *Jasta* he had belonged, your reviewer replied that he was only a trainee cadet and was never engaged in combat in the 1914-18 war. When asked what was the degree of his association with von Richthofen, he replied that he had never met him, but did once see him. . .

(9) It is not our concern here as to why your reviewer should misrepresent the contents of our book and indeed, his own "qualifications" for so doing. We are concerned solely (as we feel sure that you, Sir, will be) in correcting the record, and in protecting the high standard of personal and literary integrity of both the compilers and editors.

Your reviewer wrote: ". . . one fears that it [the book] may in time come to be quoted as a 'bible' in argument against those who treasure first-hand knowledge and nostalgic memories of von Richthofen and his squadron."

In view of the many appreciations we have received, and bearing in mind that of the first print of 5,000 copies some 4,000 have already been sold (and a further reprint will shortly be necessary) it is apparent that the time has already come when *Von Richthofen and the Flying Circus* will be (and indeed *is*) quoted by—and not against—"those who treasure first-hand knowledge and nostalgic memories of von Richthofen and his squadron"—experience which most certainly your reveiwer never had.

Letchworth, Herts. HARLEYFORD PUBLICATIONS LTD.
D. A. Russell, Director.

[It should, perhaps, be added that the reviewer of the book in question was A. R. Weyl, A.F.R.Ae.S., A.F.I.Ae.S., F.B.I.S., who (as recorded in *Flight* for March 6) died on February 23.—Ed.]

Historic Hops and Flights

I WOULD never call my friend John W. R. Taylor [April 17] frivolous, let alone "worse"; but he has spells of mischievous weakness like all of us. So here goes:

(1) I think I am right in saying that every early pioneer (powered), save the Wrights, waited for as calm conditions as possible, for the fundamental reason that no one before 1908 (except the Wrights) could control his aircraft in a wind, primarily for lack of lateral control.

(2) In 1903, to keep a powered aeroplane flying for 59 sec in a 20-25 m.p.h. wind was an amazing feat. No one but the Wrights could fly for that time—even in a dead calm—until November 1907.

(3) Leaving aside all hocus-pocus about what flying is, the Wrights were by years the first to produce a practical powered aeroplane (their No. 3 *Flyer* of 1905). They also provided the direct stimulus to European flying on two pivotal occasions: I must ask John Taylor to wait for my book for what I hope he will agree is proof of that, advanced fully (I hope) for the first time.

(4) Perhaps the greatest single blessing conferred by the Wrights on European aviation was the true concept of manœuvrability.

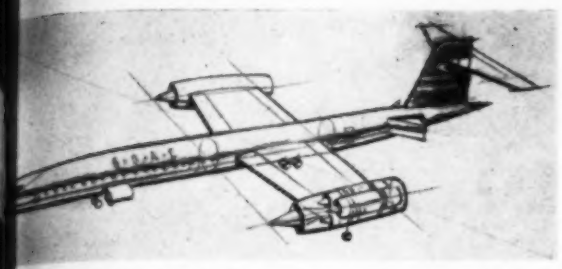
(5) From 1908 (when the first was killed) till the end of 1910 36 lives were lost on powered aeroplanes: eight were killed on Wrights, eight on Farmans (H. and M.) five on Antoinettes, four on Blériots, one on Voisins, seven on other makes, and three unknown. Not bad for the huge hourage clocked up by Wright machines from 1903 onwards.

(6) Why should history give *greater* credit to later machines when earlier ones made them possible?

(7) The top of the "pull-up" at Brooklands was no better place than the finishing straight on which to pose for a photograph and needed, in addition, friends to push up the machine. The French caption to that photo is interesting. It says: "*L'aéroplane de M. Roe prenant son élan*" (taking off). In any case, Roe would have been crazy *not* to have used the slope, especially when (as he says) he had friends to help.

Incidentally, and before the wasps get at me, let me correct "four" to "five" alleged tests by Cody in May 1908. The point about the proof of the actual date (May 16) not being known till after 1948 is that Cody's biographer wrote in 1958 that Cody "always gave the date May 16"; whereas in September 1948 he had said he "cannot—at present—give the actual date."

CHARLES H. GIBBS-SMITH.



Hypothetical Mach 1.8 airliner, one of two speeds recommended by the committee—a 180-seat, London - New York non-stop aircraft with a "conventional" structure. Service: 1971. Cost: £75-95m for 25-50

L/D and £ s d

LET us go back for a moment to December 1956, the month in which the Government-appointed Supersonic Air Transport Committee, under the aegis of the R.A.E., first met. In the same month a most significant quotation, which received little attention at the time, appeared in *Flight*. In an exclusive interview at Burbank with Mr. Hall Hibbard, vice-president engineering of Lockheed, a member of *Flight's* staff reported him as follows (issue of January 11, 1957, page 48):—

"I say that the industry—and I hope it is Lockheed—will have a prototype flying in eight years' time [1964-65], and in operation four to five years after that [1969-70] . . . I should say Mach 2.7 is about right. . . . We would have plenty of power for take-off, plenty of wing for very-high-altitude cruise, and certainly blown flaps and reverse thrust for landing. . . . As for the thermal barrier, sure it's right there, but we will just fly above it at 100,000ft. The airplane will have to go some ways. We think everything is fitting into place just perfectly."

Sales-talk? We do not think so, because at frequent intervals since that date Mr. Hibbard as well as other senior members of Lockheed's management have let fall remarks which have been consistent with those words of nearly two and a half years ago. For example, Mr. Kelly Johnson said 12 months ago that the Lockheed project would weigh 450,000 lb, would cruise at Mach 3 at 80,000ft ("There is no sense in being a *little* bit supersonic—let's go"), and would have a range (presumably transatlantic non-stop) of 3,500 miles. Wing loading would be 40-50 lb/sq ft.

Why, then, does the British supersonic committee's report recommend that we should build two airliners, one for medium range of M=1.2 and the other, of transatlantic range, of 1.8 to 2.0?

The answer can only be that the report is a purely technical assessment of the British industry's capabilities, by men who best know its limitations and experience.*

It would be impertinent to criticize the technical basis of these recommendations. Those who airily say "Mach 1.8 is hopeless, old boy—we must do Mach 3" might well be recommended to do the following instructive exercise. It can be shown that development-time (and hence, to a first order of accuracy, cost) of a new aircraft is proportional to basic weight times Mach number. Let us say that the Victor, for example, has a basic weight of 90,000 lb and a cruising Mach number of 0.90. The aircraft took about 10 years from project-office to squadron service, which is proportional to $90{,}000 \times 0.90$.

If we do the same multiplication for a Mach 3 airliner, which for transatlantic capability would probably have a basic weight of about 200,000 lb, we arrive at a development time which is *seven times* greater than that required by the Victor. Putting it another way, a Mach 3 airliner built with the same resources and man-hours as were put into the Victor would take about 50 years from project-office to airline service.

This, of course, would delight most airlines. We quote Sir William Hildred, director-general of I.A.T.A., speaking at Las Vegas on April 13:—

"If manufacturers, inspired by the dedicated designers in their project offices, suddenly throw at us a supersonic aircraft which can do 2,000 miles an hour before the rest of the system is in phase to accept it, we shall be getting into something like chaos . . ."

Which brings us to the fundamental issues that the committee's report did not attempt to solve—the political and commercial desirability of supersonic airliners. It is suggested that, in working towards a decision, the following must first be accepted:—

(1) British air transport must sooner or later be equipped with supersonic transports. (2) Upon the decision as to whether these are supplied by the British industry hangs the future of Britain as a nation which has traditionally earned its living by technology. Our primary assets are our technical skills, of which aeronautical engineering is the most complete fulfilment. (3) The nation must continue to invest in these skills to maintain itself in the front rank of technology. (For the effect of advances in aeronautical engineering upon the engineering industry as a whole, read the paper read at Southampton recently by Mr. S. P. Woodley—p. 574, this issue.) (4) Supersonic airliners will not bring about reductions in the cost of air transport—rather the reverse—though this is not to say that some passengers will not be prepared to pay an economic fare for the facility of supersonic travel. (5) B.O.A.C. will be faced with American Mach 3 competition by the time a British Mach 2 airliner could be available. As Mr. Peter Masefield has said, let history speak of the consequences. (6) B.E.A., and the economics of European air transport as a whole, will not be ready for a supersonic airliner for 20 years, and even then only in limited quantities. (7) If speed-competition brought about by technological advance is not controlled, the airlines will continue to fly from one financial crisis to another. (8) The future of air transport, and of the industry which supplies it, lies in cheap-to-operate transport aeroplanes.

The problem can now be broken down into three main parts:—

Political: It is in the national interest to keep Britain's technology vigorous and alive and in the forefront of research and invention. Aviation technology, because it embodies every facet of engineering, cannot be allowed to decay. If it does so, our primary asset—engineering—will depreciate. A further political factor which cannot be rejected as "Blimpism" or prestige-chasing is that an industry which allows others to supply its own home market with the most advanced products is a second-rate industry—or at least it will be judged as such in other markets.

Commercial: A supersonic airliner of any speed makes little sense *unless* it comes into service when the subsonic fleets have been paid for and developed (*à la* DC-4 of 1940 to the DC-7C of today) to the full; *unless* its inevitably higher costs are not passed on to air transport as a whole; and *unless* it does not deflect attention from the need to operate the bulk of air transport in aircraft designed for low-cost first and speed second.

These conditions are not incompatible; and it is possible for Britain, by pursuing wise air transport policies, to take a lead in pioneering low-cost air travel. A leading article on January 16 referred to Britain's opportunities for influencing the air transport world. It might even be said that a sound national air transport policy alone could stimulate—without the expenditure of one halfpenny of public money—the demand for bread-and-butter aircraft upon which the real future of our aircraft industry depends.

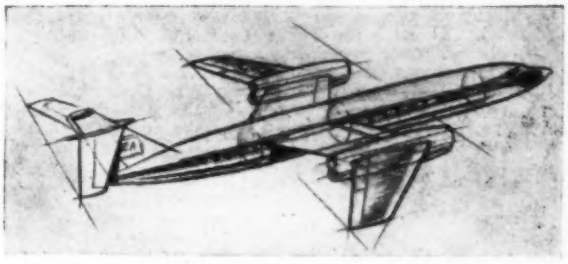
Technical: Britain's first supersonic airliner, if it is to be worthwhile competitively, cannot in view of obvious American intentions be Mach 1.2 or 1.8. The technical problems involved in a Mach 2.5 plus airliner, which would require the "seven-times-Victor" effort to solve, were discussed in *Flight* of February 8, 1957. Though advances have been made since then, the basic problem still remains: How do you achieve an L/D of 12 or more for 85 per cent non-stop transatlantic operation (for this is the initial realm of the supersonic airliner) with a wing big enough to use existing airports and to lift above 100,000ft clear of the more serious problems of kinetic heating—and to do all this with an economic payload?

This is the challenge, perhaps the greatest ever to face the British civil aircraft industry. Whatever the outcome, it will have sharpened our ideas about the essential purpose of air transport, which is to carry people and goods about the world as cheaply as possible. This is a great challenge to technology too.

It comes to this: Britain must conduct the operation of her air transport business in a manner which will stimulate a demand for very-low-fare mass travel and hence a demand for cheap-to-operate British aircraft. This can be accomplished without heavy public investment in the aircraft industry. Only with this aim resolutely in mind would it be reasonable for our national technology to be financed to meet the challenge with a British Mach 3 airliner. But it will require an all-out effort, and the cost will be immense. This is as obvious now as it was 2½ years ago.

J. M. RAMSDEN

* *On the committee, under R.A.E. guidance, were represented B.E.A., B.O.A.C., M.o.S., and M.T.C.A. The firms were: Avro, A.W.A., Bristol (Aircraft and Aero-Engines), D.H. (Aircraft and Engines), English Electric, Fairey, H.P., Rolls-Royce, Short and Vickers.*



Hypothetical Mach 1.2 airliner, the second one recommended, with shock-free wings of M plan-form. Seating would be for 100, with a range of 1,500m. Service: 1967. Cost: £50-80m for 50-100

AIR COMMERCE . . .

UP-TO-DATE WITH THE CARAVELLE

Weight and Power Increases in Prospect

HERE is a report from Mark Lambert of "Flight's" staff about the latest design progress with the Sud Aviation Caravelle, due to enter service in three weeks' time with Air France and S.A.S.

Source of the Caravelle news on this page is M. Pierre Satre (left), chief designer at Sud, and creator of the Caravelle. On the right is Pierre Nadot, chief test pilot

DURING a recent tour of the French aircraft industry in *Flight's* Gemini, I landed at Toulouse Blagnac and was lucky to catch M. Satre, Sud's chief engineer and chief designer, who was responsible for the original Caravelle concept and its pioneering engine installation. I asked him right away whether, in the light of events since 1955 (when *Flight* published a full description of the Caravelle) he had in any way changed his faith in rear-mounted engines and the twin-engined concept. His reply was typical. All single-engined jet fighters had, effectively, rear-mounted engines—and "even the ancient Chinese rockets used such an installation."

Neither was his faith in a twin-engined powerplant in any way shaken. Firstly, he said, two good engines were better than four mediocre ones and the DC-3 had amply proven the reliability of an aircraft with two first-class engines. Secondly, real safety in multi-engined aircraft depended essentially on the engines being completely separate; and he cited the case of a Pan American Boeing 707 which had lost two engines together at 1,000ft over Paris because of a difficulty which arose when water injection and de-icing were used at the same time. In the case of propeller engines, an engine failure not only caused a loss of power but a loss of slipstream-generated lift over one part of the wing with the result that the yawing moment was accompanied by a rolling moment after failure.

The Caravelle's engines were, he continued, slightly offset so that their thrust line passed through both the longitudinal and the vertical c.g. position. They were mounted high on the rear fuselage in order to avoid ingestion of foreign material either when the wing became iced or when the undercarriage might be throwing up stones when the tail was right down just before take-off. This last factor had worried Sud during the early days, but they had in fact experienced no difficulty. Nevertheless, the intakes of the two Avons had been turned slightly upwards and inwards in production aircraft.

About the independence of individual engines in multi-engine installations, M. Satre said that if carburettor icing were dangerous, then the proper solution was not to have four carburettors and four engines but to overcome carburettor icing. Similarly, any fuel system failure should not be able to affect more than one engine at a time. More specifically, about the Caravelle, he said that even if he had wanted to install four engines there was not an engine of 7-8,000 lb thrust which was as well tried or reliable as the Rolls-Royce Avon now being used.

RB.141 Installation

I next asked M. Satre about Caravelle developments and he told me about the stages at present planned which would finally lead to the fitting of two Rolls-Royce RB.141s, giving 14,000 lb thrust each, which would give the Caravelle a 50 tonne (110,000 lb plus) gross weight, raise its cruising speed to 860 km/hr (465 kt) and double its present range to 3,000 kilometres (say 1,600 n.m.). In order to provide a freight version for either military or civil use, he replied that a swing tail, *à la* Convair 880 or CL-44G, was possible, but that the first Caravelle prototype had already had a large freight door in the port side just aft of the flight deck, and that orders for such a Caravelle freighter could be taken.

The present standard Caravelle is powered by two Rolls-Royce RA.29/1s giving 10,500 lb thrust each. It has a cruising speed of 405 kt. From the 36th production machine onwards the RA.29/3 will be fitted, raising the power of each engine to 11,400 lb and the cruising speed to 430 kt. The gross weight will also increase from 43.5 tonnes to 45 tonnes (96,000 lb to 99,500 lb). Later still the RA.29/6, giving 12,200 lb, will be fitted and the gross weight and cruising speed raised respectively to 47 tonnes (104,000 lb) and 445 kt. The change from RA.29/1 to RA.29/3 simply involves the use of a different turbine blade material; this can be incorporated as a retrospective modification in the first 35 Caravelles. The RA.29/6 has an extra compressor stage which provides improved s.f.c. as well as higher thrust—but it will be possible in the future to convert RA.29/3s to /6s retrospectively. Only slight airframe changes are required to accommodate these more powerful Avons.

The final stage at present envisaged is the incorporation of two Rolls-Royce RB.141s in a 50 tonne (110,000 lb) Caravelle. Thrust will be slightly more than 14,000 lb per engine, with an s.f.c. 10 per cent lower than that of the RA.29/6. Static strength tests of the present Caravelle airframe have proved it capable of the gross weight envisaged and of the 465 kt cruising speed which will then be possible. The range available will then make the Caravelle capable of flying all the American domestic routes except the non-stop coast-to-coast. Incidentally, the RA.29/3 will have a noise suppressor, while the RB.141, with its by-pass arrangement, will probably not require one. Sud consider that the RB.141, which can be delivered as a complete engine ready for installation, is considerably more advanced than the American turbofan units.

The Production Outlook

After speaking to M. Satre, I was shown something of Caravelle production which is now arranged on a three-shift basis, seven days a week with the object of producing 25 machines by the end of this year. The four Sud factories in Toulouse alone are keeping 6,700 workers busy and an impressive shoal of aircraft is already to be seen in the new assembly hall. Some 315 sub-contractors are involved, including 18 British and 18 American. The cylindrical section of the fuselage is made in Toulouse and the wings at Sud's factories at St. Nazaire and Nantes. The tapering section of the nose is made by Sud at Marignane and the tapered tail section by Latécoère at Toulouse. Fixed horizontal and vertical tail surfaces and the engine nacelles are made by Fiat in Turin because of their experience in spot welding; and elevators and rudder are being made by the Forges de la Boissière near Toulouse. The undercarriage comes from Hispano and the powered controls from SAMM. The assembly and equipment of each aircraft takes 360,000 man-hours.

Particularly impressive is the fact that Sud have realized the importance of after-sales service and have organized not only a very large office to provide such service for all the company's products but also a special department of 250 people to deal solely with the Caravelle. The whole department is headed by M. Chabert at Paris and the Caravelle department at Toulouse by M. Colas. Sud have based their operations in this respect on those of the two companies whom they consider to be the most experienced in the world, namely Douglas and Rolls-Royce. In addition, they have been able indirectly to draw on the experience of Vickers with the Viscount. A very considerable stock of spare parts ready for immediate delivery has already been set up with 8,000 airframe parts and 1,000 systems parts; and a second stock of major sub-assemblies for crash repairs, including complete undercarriages and wings, is now being assembled.

A tremendous enthusiasm seems to have seized all Sud personnel in touch with the Caravelle project. Not a single strike or work stoppage has occurred and the number of Caravelles on final assembly is itself evidence of the capacity of Sud, and indeed of the whole French industry, to produce an effective transport aircraft. There is a real determination to provide what the Americans would term a complete transport system and not just an airframe with which the customer is left to make his own way. The Caravelle is, in fact, rapidly joining the Nord Noratlas, Fouga Magister, Sud Alouette and the Dassault fighters in the front rank of French aviation exports. If work on the Caravelle were to stop, it is said that 50 per cent of the French aircraft industry would be left idle.

The first Caravelle, being used at Toulouse for S.A.S. crew-training, made some spectacular short take-offs during my visit.

CONVAIR TEST PROGRAMME

CONVAIR still expect to have F.A.A. certification of the 880 completed by May 1, 1960—the schedule publicly announced two years ago. Three aircraft are now being used for flight tests, and the structural and engineering test programme is under way. The first aircraft to fly has, since January 27, been instrumented and used for basic performance and systems tests. The second airframe is being used for static testing and the third aircraft off the line is being used for the same work as the first. The fourth will be fully furnished and trimmed and used for acoustics, pressurization and air conditioning tests.

The first aircraft will be modified and re-instrumented as necessary (thrust reversers, for example, will be fitted in June) and the third used for taxi-testing and for finding the optimum setting for the thrust reversers.

ITALIAN AIRWAYS UNDER REVIEW

ONE of the more urgent suggestions following the collision between a B.E.A. Viscount and an Italian Air Force Sabre over Anzio last October was that a special government department should be established to deal with civil aviation matters—in particular, co-ordination of the airways system. Plans for such a secretariat received a setback after recent elections, and for the time being at least appear to be in abeyance, but it appears that the Italian Ministry of Defence and Air has decided to consult airways users and to provide an effective airways system over Italy. According to A.N.P.A.C. (the Italian Air Line Pilots' Association) some of the considerations affecting possible changes are the location of Milan's Malpensa Airport, which is considered to be too close to the military base at Cameri, and the interference to which the NDB at Biella is subject. This NDB defines Airway G-6; when it is affected airlines can easily stray towards the Alps or into a zone of jet-fighter activity.

A.N.P.A.C. has suggested moving Mortara VOR to Malpensa where it could be better supervised and where it would guide departures, arrivals and holding. To this would be added a surveillance radar.

Departure and arrival procedure would then be as follows: outbound flights might be routed on a radial of Malpensa VOR and then brought back overhead at such a height that they could pass over Biella NDB at 17,000ft. Airway G-6, defined by Malpensa VOR and Biella NDB, could then be accurately followed with a cross-bearing from Poirino overhead Biella.

Malpensa and a VOR cross-bearing would make accurate overflying of Biella possible on entering Malpensa. Direct routes that could be used by aircraft flying above 10,000ft pending installation of a full VOR airway system over Italy are: (1) Malpensa VOR, Porretta VOR, Bolsena VOR and back; (2) Malpensa VOR, Genoa NDB, Elba VOR and back; (3) Poirino VOR, Genoa NDB, Elba VOR and back.

These routes do not interfere with the entry, exit and overflying of the Milan area or with military traffic, and A.N.P.A.C. say that tens of millions of lira annually could be saved by using these routes instead of the present tracks. They have, in fact, defined a VOR airway network for the whole of Italy, including a traffic pattern for Rome, all based on existing radio aids or those which will certainly be installed in the near future.

TRUNKLINES IN THE BLACK

THE year 1958, in spite of the tail-end of the business recession and a pilots' strike that reduced the revenue passenger-miles flown by American Airlines from 5,143m to 5,021m, was a good one for the airline.

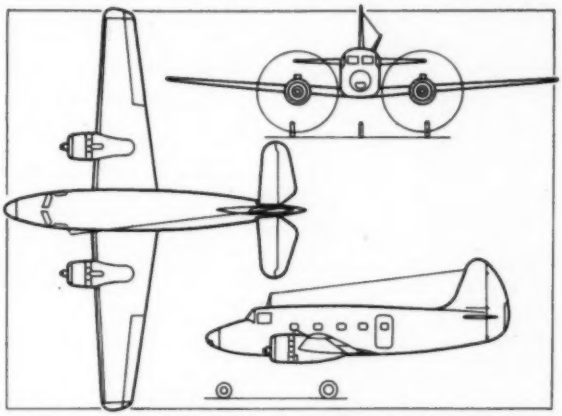
Profit for the year ending December 31, 1958, was $13,054,000, not including $3,026,000 from the sale of property. The net earnings of $16,080,000 would have been even higher (some $20,280,000) if depreciation had been continued at the previous level, but the C.A.B.'s new policies for the airlines, which came into force in January 1958, meant that American had to raise the residual value of its aircraft and extend the life of its DC-7s. Later, after the Supreme Court action which disallowed C.A.B.'s right to establish airline depreciation policies, American reverted to their original policy of setting 1961 as a common retirement date for DC-7s acquired in 1957 and 1958. On January 1, 1958, American also started capitalizing interest expenses on the deposits placed with manufacturers for the purchase of new equipment; this increased the earnings for the year by $996,000.

American are buying 110 new aircraft between 1958 and 1962 and, with engines and propellers, their capital requirements are $445m. About $20m had been spent by the end of 1958, and deposits with manufacturers were about $59m. Financing with insurance companies has been arranged to the tune of $135m, but $200m remains to be found out of earnings.

American's revenue in 1958 increased by 3.7 per cent on the previous year's figure and the total of $317,240,000 was a record. Mr. C. R. Smith, the airline's president, said that jet services had enjoyed favourable public acceptance, load factors were high, and that the demand for air travel was strong.

While American Airlines were among the many which experienced labour troubles last year, United were not, and they benefited from their competitors to an extent that gave them a record year. Net profit was $13,752,000 with an extra $548,000 coming from the sale of aircraft—a total nearly twice that of the previous year.

By holding operating expenses down to an increase of 6 per cent while revenue rose by 13 per cent, revenue per ton-mile rose from 49.4 cents to 51 cents while costs per revenue ton-mile fell from 47.6 to 46.6 cents. In the president's statement to the airline's shareholders, Mr. W. A. Patterson said that "the emergency increase in airline fares, granted as a temporary increase in February 1958, was of appreciable help. Elimination of various discounts in October and reduction of the Family Fare Plan discount were also beneficial." He would continue to press for higher fare levels. "Despite temporary fare relief" (which the C.A.B., incidentally, estimate to be equivalent to a total increase of about 10 per cent in 1958), "industry earnings were little improved over 1957. Price and wage increases continued their upward pressure on costs, pointing clearly to the need for permanent relief through action by the Civil Aeronautics Board."



Here is a general arrangement drawing of the Peking NR.1, Communist China's first transport aircraft. It appears to be similar in purpose to the Dove of 14 years ago; it carries eight passengers and is powered by two 520 h.p. radial piston-engines. It flew last September

PROPOSED AER LINGUS COACH-AIR SERVICE

NEGOTIATIONS are now in progress between the Air Ministry and Ministry of Transport and Civil Aviation and the Irish Department of Industry and Commerce regarding an Aer Lingus proposal to operate a coach-air service between Dublin and Royal Air Force, Valley, Anglesey. It is understood that Valley would remain a Royal Air Force station on the same joint-user basis as exists at Royal Air Force, Manston.

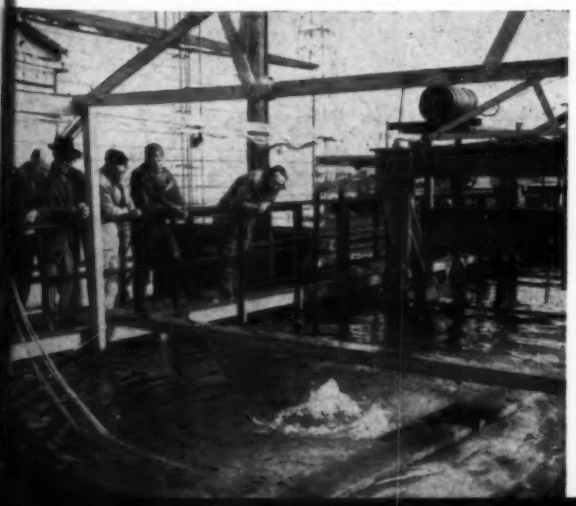
The proposed operation appears to be an attractive commercial proposition, for Valley is only 70 statute miles from Dublin Airport, which would entail block-times of 25 and 20 minutes for the Friendship and the Viscount, respectively. Coach connections to the populated centres of Lancashire, Yorkshire and the North Midlands would be routed via Bangor and Chester, and to the Midlands proper, via Bangor and Shrewsbury.

Using the excursion return fare from Dublin to the Isle of Man as a basis (the distance is almost the same), the air portion of the fare would be £3 15s excursion return.

Below is a table of comparative schedules and rates to existing Aer Lingus outstations in the region:—

	Flying time (minutes)			Excursion return fare
	DC-3	F.27	V.808	
Dublin to:—				
Birmingham	95	65	60	£8 14s
Liverpool	65	45	N/A	£6 11s
Manchester	75	55	50	£6 19s
Valley	45	35	30	£3 15s

Note: The runway at Liverpool (Speke) is unsuitable for Viscounts.



In the Boeing 707 test tank at Seattle water spurts from a 22in cut in the fuselage deliberately made to study fail-safe characteristics. Six cuts were made in the fuselage, "and in no case," report Boeing, "did the damage spread." Note the skin diver

The Viscount as a DC-3 replacement: This is the interior of a f Viscount 701, one of several now converted from 47 to 63 seats. years old, and no longer all in front-line service, they have al taken over DC-3 routes in Germany, and will soon run the follo Corporation services:—Gatwick - Cologne - Hanover, Gatwick - Je Gatwick-Dinard. The seats are by Aircraft Furnishing Ltd., as are tho in the tourist cabin of the Argentine Comet 4s now being deliver

AIR COMMERCE . . .

B.O.A.C. No. 2 ON THE ATLANTIC

AS predicted in *Flight* of March 20 ("Sharing the North Atlantic Cake"), B.O.A.C. has now supplanted T.W.A. as the No. 2 North Atlantic passenger airline.

This really solid achievement comes after a ten-year chase of T.W.A.; and it comes also at a time of increasingly adverse comment about the Corporation. (*Sunday Express:* "Bloated . . . indefensibly inefficient . . . in a lamentable state." *Daily Mail:* "Blow some of the surplus fat off this bloated Corporation . . .")

The fact remains that, on the world's most important route during the last three months of 1958, B.O.A.C. carried 23,387 passengers in both directions, compared with 23,080 carried by T.W.A.

The disparity is small, but an extrapolation of the past rates of growth of the two airlines suggests that it is likely to widen. No. 1 passenger carrier of the North Atlantic is, of course, Pan American; their total passenger load in the last quarter of 1958 was 61,510—more than T.W.A. and B.O.A.C. combined.

B.O.A.C., which is flying through many adversities at the present time, has good reason to be proud of its achievement. The Corporation climbed into third place ten years ago, having overtaken S.A.S., Air France and T.C.A. in 1948/49. Despite a dip in growth-rate in 1954 and 1955 (owing to capacity shortage), B.O.A.C. has thus held third place for nearly a decade—until now.

The breakdown of B.O.A.C.'s North Atlantic (U.K. - New York) traffic in the last quarter of 1958, with load factors in parentheses, was as follows: First class, 9,403 (68 per cent); tourist, 5,427 (65 per cent); economy, 8,557 (55.5 per cent). It will be noticed that, in the period reviewed, tourist traffic was a substantial proportion (nearly one quarter) of the Corporation's total traffic. This compares with the results of all N. Atlantic carriers combined: tourist business has now dwindled to about one eighth of the total. Of the 17 North Atlantic carriers, three have abolished tourist class altogether: S.A.S., El Al and Aerlinte.

Footnote: A statement issued by the Corporation last week said that U.K. - U.S. traffic (both ways) in the first quarter of 1959 was no less than 54 per cent above the first quarter or 1958. Bookings for the summer were already 20 per cent up on last year's.

HUNTING'S TROOPING CONTRACT

AS foreshadowed in *Flight* last week (p. 516) the Air Ministry Britannia trooping contract to the Far East has been awarded to Hunting-Clan. The first flight will leave London Airport on May 15 and thereafter there will be six flights a month.

For Hunting-Clan and British and Commonwealth Shipping, who own the aircraft, the award affirms an act of faith in placing an order for two Britannia 317s specifically (although not exclusively) for the task of carrying Service personnel and their families to Singapore and Hong Kong. Several tenders, at first based on the use of three M.o.S. Britannia 252s, were submitted to the Air Ministry last year, but only Hunting-Clan and Air Charter backed their applications by actually operating Britannias of their own.

Both Hunting aircraft are to be used on what will be virtually a scheduled service but they will also be available for a limited amount of charter work. The airline is also tendering for the trooping contract to Aden, Nairobi and Nicosia, probably to be awarded in June, and another aircraft is on option against this and the acceptance by the A.T.A.C. of the Very Low Fare proposals of Eagle, Hunting-Clan and Airwork.

The interior of the Britannia 317s has been designed by Charles Butler Associates, and although a high density layout is employed the décor is "unusually luxurious" for a troop transport. As specified by the Air Ministry all 114 seats (manufactured by Flight Equipment) are rearward facing.

CAN 20,000 PILOTS BE WRONG?

QUESTIONS of crew complement figured prominently among the many topics which were the subject of I.F.A.L.P.A comment and recommendation at the Association's recent fourteenth annual conference at Helsinki.

I.F.A.L.P.A.'s 34 member-associations clearly reaffirmed that there should be a third pilot in jet transport cockpits. The pilots argue that with greater speed, more positive traffic separation and new equipment, the onus of engineering, communications, piloting and navigation is increasing the pilot's workload, and that the specialist crew members of the past are becoming redundant. Higher aircraft speeds, for example, have encouraged direct pilot/controller communications systems and dispensed with the need for a radio operator; and positive traffic control has resulted in pilot-operated systems such as VOR, ADF, Decca/Dectra, VHF/DF, Consol and Loran. At first sight navigators would seem to have been made busier by higher speeds, but more radio navigation aids and a reduction in "dog-legs" and pressure pattern flying has increased the accent on pilot-navigation.

Much the same arguments are applied to the duties carried out by the flight engineer. Jet transports are said to be simpler to operate than the types they succeed and the net effect is to reduce the amount of minute-by-minute performance control that is needed. Monitoring is still required, the pilots say, but the function could equally well be performed by a trained pilot; and a third pilot would be a fail-safe precaution.

Introducing trained-engineer pilots into the cockpit will not be easy; suggestions that flight engineers should be replaced by pilots have so far been met with strikes and the threat of strikes (for example, see *Flight*, February 13). Shifting of the work from one specialist to another, I.F.A.L.P.A. suggest, would be simpler if crew members had the same training and the same labour organization, and fundamentally there is no reason why pilots' and engineers' organizations should not be merged. But "the nature of a labour organization [is such] that it will seek to preserve the full extent of its domain with greater vigour if its very *raison d'etre* is taken away . . . by technological change."

IN DEFENCE OF A CAPTAIN

READERS of *Hansard* for April 16 will have been stimulated by Sir Lionel Heald's defence of Capt. W. H. Hankin—the pilot of the B.E.A. Viscount which crashed at Prestwick a year ago. The accident was due—according to the M.T.C.A. investigation—to a misreading of the altimeter (*Flight*, April 3, p. 478).

Sir Lionel's criticisms were levelled at the Minister of Transport. He spoke of the "inhuman and soulless machinery" which but for his own "fire-brigade" action as an M.P., would have lost Capt. Hankin his licence. Briefly, he accused the Ministry of depriving Capt. Hankin of his statutory rights to cross-examine witnesses and demand a public inquiry into the accident.

The Minister, Mr. Harold Watkinson, said in reply that he did not think that in the circumstances there was "cause either to withdraw or cancel Capt. Hankin's licence." If Sir Lionel thought they were going to do that, "he was rather misjudging us." The Minister added: "I sincerely believe that this man had a fair deal, but I equally accept that he may have misunderstood his position." He would therefore see whether the position as to the rights of a pilot after an accident could be clarified.

Footnote: Pilots are re-reading the "OPS/ENG" meeting of I.A.T.A. which took place in London as long ago as March 2-4, 1954. One of the subjects for discussion was ambiguity of threepoint altimeters, and there is no doubt that this report showed a great deal of wisdom-before-the-event. A sample quotation is as follows: "Studies show that the conventional three-pointer altimeter is a difficult instrument to read quantitatively. This is illustrated by the fact that of the readings by U.S.A.F. pilots, approximately 12 per cent were in error by 1,000ft or more. Interpretation time averaged 7.1 seconds . . ."

"WILL THE LOUNGE NOW WAITING . . .?"

PASSENGERS at the new Washington International Airport which is now being built at Chantilly, Virginia, will move from the terminal to their aircraft in a new "mobile lounge," it has been decided by the Federal Aviation Agency.

It seems to have become generally accepted by the planners of modern airports that the finger-and-gate system—pioneered in America—is the classic solution to the problem of getting passengers to and from their aircraft. The only other generally accepted solution, now considered inefficient and out of date, is the apron coach. That it should now be revived, albeit with a

...cy name, is a surprising development. It should provide cause ...contemplation among those who are now putting the final ...hes to the design of London Airport's new international long- ...building, which (according to the Millbourn recommenda- ...is) is to be built entirely on the finger-and-gate principle.

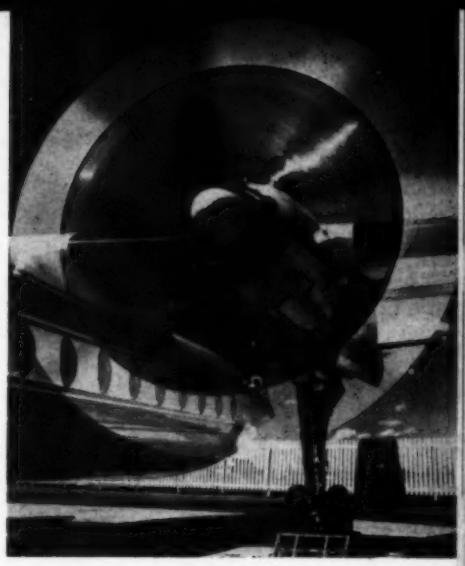
The F.A.A.'s "mobile lounge" has not yet been designed, but ...prototype is being built, for completion by January 1, 1960, ...t a cost of about £35,000. Production units might cost £21,400. It will stand on "cushioned stilts," will measure approximately 15ft by 60ft, and will accommodate about 80 passengers (i.e., two ...o a big jet), and will be driven from either end like a tram.

Advantages appear to be as follows: (1) Cost: an airport with a fleet of these vehicles would be cheaper to operate—according to the F.A.A., £380,000 *v.* £315,000. Furthermore, there would result a saving of about £1m in terminal-construction costs, taking the new Washington airport as an example. (2) It would eliminate increasingly long walking distances. As traffic grows, gate positions tend to be occupied further and further away from the terminal building. (3) It would permit much greater flexibility in the parking of aircraft and in fuel and servicing facilities.

MORE LIKE OLD TIMES

REPORTS of a cheering recovery in the rather long-depressed growth of air transport are now coming in. The British carriers, for example, improved their loads in the month of January 1959 by 14.7 per cent compared with January 1958—to a total of 22,464 l.t.m. Load factor, however, fell from 54.1 per cent in 1958 to 53.5 per cent. The best results were achieved by the independents operating as "associates" of the Corporations; their traffic leapt by 33.1 per cent compared with January 1958.

Looking at the year as a whole, it seems that loads went up by 6.1 per cent for the year ending January 1959 to a figure of 332,159 load short-ton miles, though this was accompanied by a drop in load factor of four percentage points to 58.3 per cent.



Fluorescent paint has been applied—most effectively—to the Rotol propeller of this new production F-27 Friendship at Hagerstown, Maryland

Provisional figures issued by the M.T.C.A. suggest that traffic in the month of February 1959 was 10 per cent better than in February 1958. Taking January and February together, traffic appears to be 12 per cent greater than last year—"representing a substantial recovery in traffic growth, which in January and February 1958 was only 1 per cent up on the previous year."

As previously recorded in these columns, American airline results for the calendar airline year 1958 were the poorest since the war—as indeed were those of all the I.C.A.O. member-countries, whose growth-rate was 5 per cent compared with the classic 15 per cent since 1946. The U.S. carriers' loads increased by only 2 per cent. But there are strong signs of buoyant recovery. *Flight* recorded the recent optimistic remarks of an official of the National City Bank of New York (April 10 issue); and now it seems likely that the American airlines will report the highest revenues in their history for the first quarter of 1959. Strong gains in airline shares on the New York Stock Exchange have been reported in recent weeks.

BREVITIES

B.O.A.C. and B.E.A. opened a new sales office at 100 and 102 Cheapside, London, E.C.2, on April 17.

* * *

A Marconi S.264 50 cm surveillance radar is being installed at Jersey airport. The equipment should be ready for use in June.

* * *

K.L.M. are to provide 83 per cent of their total seats on the North Atlantic this summer in the economy class. The airline is reported to be planning the purchase of eight U.S. medium range jets for service in 1962.

* * *

Mr. Reginald George Grout, M.Inst.T., chairman and managing director of The General Steam Navigation Co., and deputy chairman of Silver City Airways, will become president of the Institute of Transport in succession to Maj. Gen. G. N. Russell, C.B., C.B.E., M.Inst.T., on October 1.

* * *

The average weight of a passenger's baggage is 23½ lb per piece. This is the conclusion of a survey by seven American domestic airlines, which has led to a request to the F.A.A. to waive baggage-weighing formalities. One airline has estimated that the new system would save it $150,000 a year in salaries alone.

* * *

The Hungarian airline MALEV, according to a press release from the Hungarian news service in London, has had an accident-free record since 1949. In 1958, Ferihegy (Budapest) handled more than 19,000 movements; foreign transit passengers exceeded 49,000, while incoming and outgoing passengers were about 242,000.

* * *

Boeing 707 fuselage water-tank fatigue tests, begun in June 1958, were recently completed with tests at a dP of 10.35 lb/sq in. After 50,000 pressurization cycles at normal pressure, the upper fuselage was sawn through and the cuts extended after each two cycles. Damage did not spread "even when cuts reached a length of 22in."

Here, from a Rolls-Royce publication issued at Las Vegas (see p. 565), is a new angle on the Avro 748. The first machine of the type will fly in February next year. The 748 is a 36/44-seater, pressurized, and engined with Dart RDa.6s

B.E.A. propose to start Viscount services to Moscow on May 17. Aeroflot's reciprocal Tu-104 services will probably begin at the same time.

* * *

Ceylon has now been granted traffic rights in China and Air Ceylon will shortly operate a weekly service between Colombo and Canton via Singapore and Rangoon. Comet 4s or Electras are being considered for the service.

* * *

Today, April 24, the day after the Westland Heliport opened, Bristow Helicopters will start operation of a helicopter taxi service with Westland Widgeons from the Battersea site. Freight and passengers will be carried.

* * *

At Delhi on April 16, Mr. Krishna Menon, India's Minister of Defence, flew for 40 minutes in the Dart Herald. The aircraft was piloted by S/L. H. G. Hazelden; Capt. R. Warren of B.E.A. is acting as co-pilot on the tour.

* * *

Spares for the AW.650 Argosy will be ordered on provisioning cards coloured pink, yellow or green, depending upon usage-rate of the component concerned. A booklet describing the after-sales service offered with the Argosy has been published by A.W.A.

* * *

Depreciation-rate of the DC-8 by K.L.M. will be at a rate of £1 per minute, according to Mr. R. J. Vogels, the airline's director of public relations, in an address to the Anglo-Netherlands Society in London on April 17. He spoke also of "restrictive air policy which hinders further expansion."

* * *

Latest news about the controversy over B.O.A.C.'s Tokyo - San Francisco route as *Flight* goes to press is that, unexpectedly, the C.A.B. examiner has upheld Northwest's contention that the operation of this route would not be in the "public interest." Previously the Board had ruled that Tokyo *could* be included under the U.K.-U.S. air agreement (which presumably took U.S. public interest into account) about B.O.A.C.'s Hong Kong - U.S. route.

* * *

On April 16 Aerolineas Argentinas inaugurated the "first phase" of their Comet 4 operations with a flight from Buenos Aires to Santiago de Chile. The flight of 850 miles was completed in the record time of 1 hr 49 min. Aerolineas jet operations call for five services per week between Buenos Aires and Santiago; four between Buenos Aires and New York, from May 29, and two between Buenos Aires and London from May 19. The second phase will begin in June 1960 following delivery of Comet 4s No. 4, 5 and 6, and will consist of daily services to New York and to Santiago de Chile and four services per week to London from Buenos Aires.

SERVICE AVIATION

Royal Air Forces and Naval Flying News

Marshal of the R.A.F. Sir Dermot Boyle, C.A.S., shaking hands with W/C. I. J. De la Plain (O.C. Technical Wing) at Laarbruch during his recent tour of R.A.F. units in Germany referred to on this page. At left is the station commander, G/C. C. V. Winn

"Eagle's" Royal Visitor

THE Queen is to visit H.M.S. *Eagle* next Wednesday (April 29) and will spend four hours aboard the carrier in the Channel off Portland Bill. This will be Her Majesty's first visit to *Eagle* (commanded by Capt. J. B. Frewen, R.N.) since launching her at Belfast in 1946.

The Flag Officer Aircraft Carriers, Vice-Admiral C. L. G. Evans, is to meet the Queen ashore at Weymouth Pier and accompany her out to the carrier—which flies his flag—in the barge of the Commander-in-Chief, Portsmouth.

During her visit to the carrier, Queen Elizabeth is to watch a 60-minute flying display—from an observation position high above the flight deck—by squadrons of Fleet Air Arm aircraft. The programme will include a fly-past by Sea Hawks of Nos. 806 and 898, Sea Venoms of 894, Gannets of 814 and Skyraiders of No. 849A Flight; a rescue demonstration by Whirlwinds; and A.S. bombing by Gannets.

Royal Passengers

ON their visit to Rome, the Queen Mother and Princess Margaret were flown from London Airport last Monday by a Comet 2 of No. 216 Sqn., R.A.F. Transport Command, captained by S/L. E. P. Pullan. They are due to fly from Rome to Paris tomorrow (April 25) by the same aircraft.

These are the first flights made by members of the Royal family since it was announced on April 5 (by Mr. George Ward, Secretary of State for Air, in a written Parliamentary answer) that they would use Comet 2s of the R.A.F. for longer journeys.

C.A.S. in Germany

A SHORT tour of Royal Air Force units in Germany was recently made by the Chief of the Air Staff, Marshal of the R.A.F. Sir Dermot Boyle. His purpose was to address as many R.A.F. officers as possible and to discuss local operational problems with the Commander-in-Chief, Air Marshal Sir Humphrey Edwardes Jones. The C.A.S. met squadron aircrew and airmen at Wildenrath, Gutersloh, Laarbruch (see photograph above) and Geilenkirchen, where he presented the Duncan Trophy—for air-to-air firing—to No. 3 Sqn., which is equipped with Javelins.

C-in-C. Coastal Command

IT was announced as we closed for press that Air Marshal Sir Edward Chilton is to succeed Air Marshal Sir Bryan V. Reynolds on June 1 as A.O.C-in-C. Coastal Command, on the latter's retirement from the Service. Air Marshal Chilton has been A.O.C. Malta since November 1957 and will be succeeded there from May 19 by A.V-M. W. G. Cheshire, with the acting rank of air marshal.

The Anniversary Concert

FOR the fourth R.A.F. Anniversary Concert London's Royal Festival Hall was well filled on April 14, and the R.A.F. Benevolent Fund should benefit accordingly.

The occasion was honoured by the presence of Princess Margaret, and among those present were Mr. George Ward, Secretary of State for Air; Mr. Airey Neave, Under-Secretary; Marshal of the R.A.F. Sir Dermot Boyle, the C.A.S.; and Viscount Knollys, chairman of the Fund. During the interval four of the eleven surviving holders of Air Force V.C.s were presented to the Princess: they were A.V-M. F. H. McNamara, A. Cdre. F. M. F. West, W/C. L. H. Trent and W/O. N. C. Jackson.

As in past years the programme was given jointly by the Hallé Orchestra under Sir John Barbirolli and the Central Band of the R.A.F. under W/C. A. E. Sims, with Gina Bachauer as this year's soloist. Probably the loudest applause of the evening was for two cornet sextettes sparklingly executed by R.A.F. bandsmen—S/Tech. S. Tamplin, S/Tech. A. Carter, Jun. Tech. N. Griffiths, S/Tech. A. Tilley, Cpl. Tech. B. Millington and S.A/C. W. Kilgour.

43 Celebrates its 43rd

AT the Paviers Arms, Westminster, London, last Saturday No. 43 Squadron (Fighting Cocks) Association foregathered to celebrate the unit's 43rd birthday. Many of the present-day members made the journey from Leuchars and two of the very early officers, Lts. Lingham (now a director of Heston Aircraft) and Hall, both of whom served with 43 in 1917, attended.

Many famous aeronautical people have served with the "Fighting Cocks" and the list of past members sending messages regretting non-attendance came from five continents and included the first C.O., Marshal of the R.A.F. Lord Douglas of Kirtleside; Lord Balfour of Inchrye; and Cyril Uwins, one of the squadron's first pilots and now deputy chairman of the Bristol Aeroplane Co. Ltd. Regrets because of illness were received from A.V-M. C. G. Lott, who was to have taken the chair. His place was taken by S/L. R. E. Le Long, whose first task was to receive a set of aircraft models presented by Jimmy Beedle, as the association's secretary.

S/L. Langer, the present C.O., said the three months' detachment in Cyprus was the high spot of the year and pointed out that the Hunters being used for ground attack brought the rôle of the squadron back to that practised in World War 1.

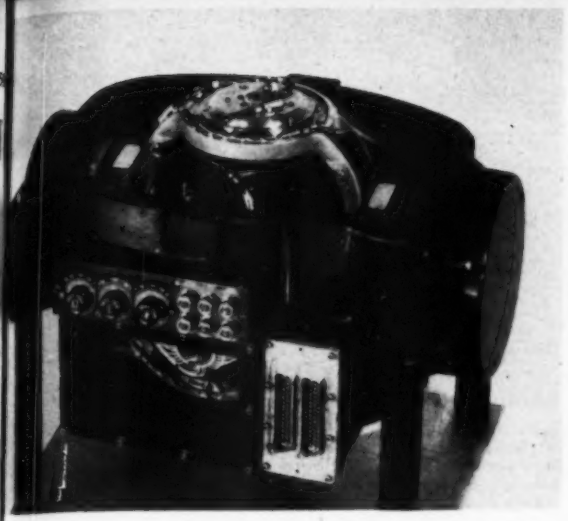
Coming Reunions

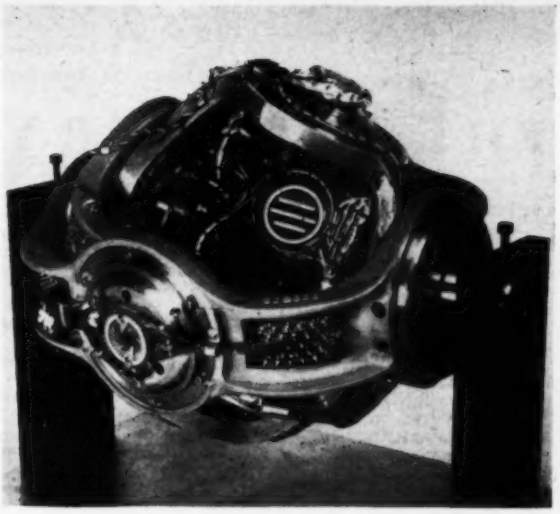
ARRANGEMENTS have been announced for the following R.A.F. reunions:

R.N. Seaplane Bases, Port Said and Alexandria (No. 269 Sqn.): Thirty-seventh all-ranks' reunion at the Chicken Inn Restaurant, Wilton Road, Victoria, London, S.W.1, on Saturday, May 2, at 6 p.m. Hon Secretary, W. C. Shilling, "Selgrove," Kewferry Drive, Northwood, Middx.

No. 46 Sqn.: Forty-second annual officers' dinner, Park Lane Hotel, London, W.1, on June 6. Further details from S/L. Peter Gifkins, Officers' Mess, R.A.F. Linton-on-Ouse, York.

Three members of the R.A.F. who recently completed a 13-week propulsion course at Rocketdyne on the Thor IRBM and its systems: from left to right, C/Tech. S. Allen, J/Tech. G.R.J. Fryer, and Cpl/Tech. J. G. Webb. As illustrated elsewhere in this week's issue, the R.A.F. fired its first Thor, at Vandenburg A.F.B., on Thursday last week





The latest version of the Minneapolis-Honeywell miniature inertial platform. A window is provided to allow initial optical alignment together with trimming potentiometers. The picture on the right, of the gyro and gimbal assembly, shows some of slip-rings and gyros

LIGHTWEIGHT INERTIAL-NAVIGATION SYSTEM

Joint Anglo-American Development and Production

By D. O. FRASER AND B. A. C. STACK*

OFTEN the first question when considering a new navigation device is its weight; and inertial navigation depends on the conservation of momentum, a principle not easily associated with lightness. Nevertheless, the Minneapolis-Honeywell Regulator Company has developed a complete all-attitude inertial platform weighing only 28 lb and contained in a cylinder of less than 10in diameter by 14in long. All the associated electronics are contained in a separate pack, smaller in volume, weighing 26 lb so that total weight of the system is only 54 lb. The secret of this compactness lies in the use of miniature components and integrated design. The three GG49 miniature integrating gyros used are fully floated, inertial-quality gyros developed by Minneapolis-Honeywell from the principles first enunciated by Dr. Draper of the Massachusetts Institute of Technology. Although its performance is comparable to that of any other inertial gyro in production, the MIG, as it is called, is less than one-tenth as heavy and weighs under 8 oz. The three GG56 accelerometers on the platform are of the pendulous current-balance type and weigh only 7 oz each. A number of parts are common to both the gyro and accelerometer. An early version of this platform was described in *Flight* for May 16 last year.

An important feature of this platform, and one also contributing to its compactness, is that it was designed from the start as an integral unit, the specifications for the MIGs and GG56 accelerometers together with the gimbal system having been derived from the overall platform specification. Common power supplies have therefore been provided for all components, an advantage in view of the fact that slip-rings must be used to transfer power from the external source, through the gimbal bearings to the gyros and accelerometers mounted on the innermost gimbal. The components also operate at a uniform temperature of 180 deg F at which the platform is maintained by an internal heater. The high operating temperature is of great advantage in applications where high ambient temperatures are expected, because it avoids the need for refrigeration; considerable weight penalty might otherwise be incurred.

It is the remarkable sensitivity of present-day gyros and accelerometers which has made inertial navigation possible and these components form the nerve-centre of an inertial platform. But such a platform is much more than a simple assembly of these sensitive components. If their accuracy is to be fully exploited, much attention must be given to the design of the limbs and muscles of the system—the gimbals, torque motors, synchros, slip-rings and so on. Many development problems and teething troubles had to be overcome during the development of the Honeywell miniature platform assembly, quite apart from those concerned with the gyros and accelerometers. Because the strength of the gimbals and power required to drive them are functions of the weight of the gyro and accelerometer assembly, the total weight of an inertial platform is nearly proportional to that of the gyros and accelerometers. The use of miniature components therefore results in a saving of overall platform weight of an order of several times compared with equivalent systems.

The small size and weight of the MIG has been achieved without any significant sacrifice in performance. Moreover, further developments of this miniature gyro promise to put it in a performance category even superior to that of instruments ten times its weight. This may have far-reaching effects on inertial-gyro technology, because the weight saved in miniature platforms based on instruments of this kind might allow an extension of weapon performance. Inertial systems of this type could also be applied to a much wider range of aircraft and missiles than has been considered so far.

The miniature platform shown above uses the three rate-integrating gyros for stabilization in azimuth, roll and pitch. Accelerometers are mounted in the two horizontal axes and provide vertical stabilization by sensing components of the gravity vector when the platform is not vertical. Their outputs are used to slave the two levelling gyros so as to keep the platform horizontal and also to indicate lateral acceleration signals which can be integrated in turn to provide velocity and distance flown. The azimuth gyro gives direction of horizontal motion. The third accelerometer can be used to indicate motions in the vertical plane.

The miniature platform is in itself a short-term inertial-navigation system and can be used for guidance of missiles or manned aircraft of limited endurance. Alternatively, the system may be combined with other navigation aids such as Doppler, in which case the short-term stability of the inertial system smooths the velocity signals of the Doppler in addition to providing a memory during lapses in Doppler signal reflections, such as might occur during pronounced manœuvres. Apart from inertial navigation, the platform provides a stabilized reference which may be put to a number of uses in any weapon system. It could, for example, be used as a heading- or vertical-reference for aircraft control, flight instrumentation, radar stabilization or bombing devices. A particular instance is the provision of an accurate heading reference for use with Doppler where the compass is the main source of navigation error.

The miniature platform and other Minneapolis-Honeywell products are available in this country through Honeywell Controls Ltd. of Greenford, Middlesex. Manufacturing licences in this country for the full range of Minneapolis-Honeywell gyros are held by English Electric. Delivery of the first few MIGs built entirely from British components is expected early this summer. These inertial components are being manufactured in a newly equipped factory forming part of English Electric Guided Weapons Division at Stevenage, Herts; the plant is probably the best equipped of its kind in Europe for production of precision instruments of this class. The Aeronautical Division of Minneapolis-Honeywell Regulator Co. and English Electric collaborate closely both in production and exchanging information on future development by both companies. Both already have considerable experience in inertial navigation developments, and their combined resources should lead to rapid progress.

The importance of this area of development cannot be overstressed, and it appears that inertial navigation will be as universal in its application as the time-honoured celestial methods. The new techniques are already being used in vehicles ranging from submarines to spacecraft.

---

* *Mr. Fraser is with English Electric Aviation Ltd. and Mr. Stack with Honeywell Controls Ltd.*

THE INDUSTRY

Piston Engines Make News

ON the principle that "Man bites dog" is news, Bristol Siddeley Engines Ltd. have remarked that in these days of turbojet and turboprop developments the piston engine is still an important item in their affairs. Altogether, they say, over 60,000 Hercules engines of different marks have been made, and over 500 civil aircraft so powered are still achieving yearly engine totals of over 1,000,000 hours. The most recent Hercules developments, i.e., the 759 and 730 engines, are still in production at Bristol for the French Noratlas and the Spanish C.A.S.A. Azor.

In addition S.N.E.C.M.A. in Paris are in full production with the 759 and have to date produced some 720 engines. Nord Aviation have so far received orders for 353 Noratlas aircraft with Hercules engines, as follows: French Air Force, 200; West German Air Force, 112; French airlines and export orders, 41.

The reliability record of the Hercules Noratlas installation is high. Engines are running to 1,200 hours between overhaul, state Bristol Siddeley, and achieved lives are 94 per cent. Involuntary engine removals average the low rate of one per 7,376 hours' flying.

While the latest version of the Centaurus family—the Type 173—is no longer in production, the company will be occupied for many years in overhauling these engines. They are, of course, installed in the Beverley which, together with the Hercules-engined Hastings, provides the major capacity of Transport Command.

Goodyear Promotions

HAVING been assistant divisional manager of the Western Division of the Goodyear Tyre & Rubber Co. (Great Britain) Ltd. since March last year, Mr. W. H. J. Underhill has now been made divisional manager, with headquarters in Bristol. He succeeds Mr. H. Dillistone, who is retiring from the company in the near future.

W. H. J. Underhill

Mr. Underhill has had a long and much-travelled association with the Goodyear organization, which he joined in 1928. In that year he was transferred to Goodyear-India, then in 1931 was appointed manager in Burma. He returned to India in 1935, joined the Army from Madras in 1940 and after demobilization in 1945 was made manager for South India. It was this post he left to become export operating manager, Wolverhampton, in 1954 and subsequently assistant divisional manager for the Western division.

Goodyear also announce the appointment of Mr. F. K. Wheatley as assistant manager, Government and National Accounts Division, working from the company's headquarters in Wolverhampton. He was previouslv manager, truck tyre replacement sales, Wolverhampton.

Packing units of an Emiac analogue computer at the Hayes factory of E.M.I. Electronics Ltd. for despatch to Armstrong Whitworth Aircraft at Coventry. The computer, which will cost over £55,000 and will be one of the most powerful of its type in this country, will be capable of studying the performance of complete new guided weapon or aircraft systems while they are still on the drawing board

Tip-tanks—of 250 gal capacity—for the Canberra are among the range of plastic drop-tanks manufactured by Bristol Aircraft Ltd. For the same strength and weight as metal tanks, plastic tanks are stated to have better aerodynamic performance and to be easier and cheaper to make. The Bristol design also offers advantages in the storage and handling of these tanks

Rotol Board Changes

FOLLOWING the outright purchase of Rotol Ltd. by the Dowty Group on March 31, the first meeting of the reconstituted Board of Rotol took place on April 9.

Sir George Dowty and Mr. Robert F. Hunt, chairman and deputy chairman respectively of the Dowty Group, have joined the Board; Sir George has been elected chairman of the company and Lt-Gen. Sir John Evetts deputy chairman; and the other members of the Board are Mr. C. J. Luby (managing director), Col. C. W. King (works director) and Mr. L. G. Fairhurst (technical director). Mr. R. Raff remains company secretary.

Plessey Nucleonics Expansion

NEW appointments have been announced by Plessey Nucleonics Ltd. as part of their plans for a current scheme of reorganization and expansion.

Mr. G. V. Hough, M.A., previously commercial manager, now becomes advanced projects manager and will also take a special interest in the company's export activities; Mr. J. S. Crick, A.M.I.Mech.E., A.F.R.Ae.S., who was formerly with the British Oxygen Co. Ltd., joins Plessey Nucleonics as sales manager; and Mr. B. Daniel, G.I.Mech.E., a sales liaison engineer with the company, is joined by Mr. R. G. Jolliffe, A.M.I.E.E., from Hayward Tyler Ltd., and A. Trott, A.Inst.P., from the A.E.I. Ltd. research laboratories.

IN BRIEF

Following a reduction in the price of pure magnesium, Magnesium Elektron Ltd., sole producers in this country, recently reduced the prices of some of their magnesium alloy ingots.

* * *

Mr. E. J. Lassen, who has been export manager of Bakelite Ltd. since 1945 (when the export unit was established), has retired after 28 years' service with the company.

* * *

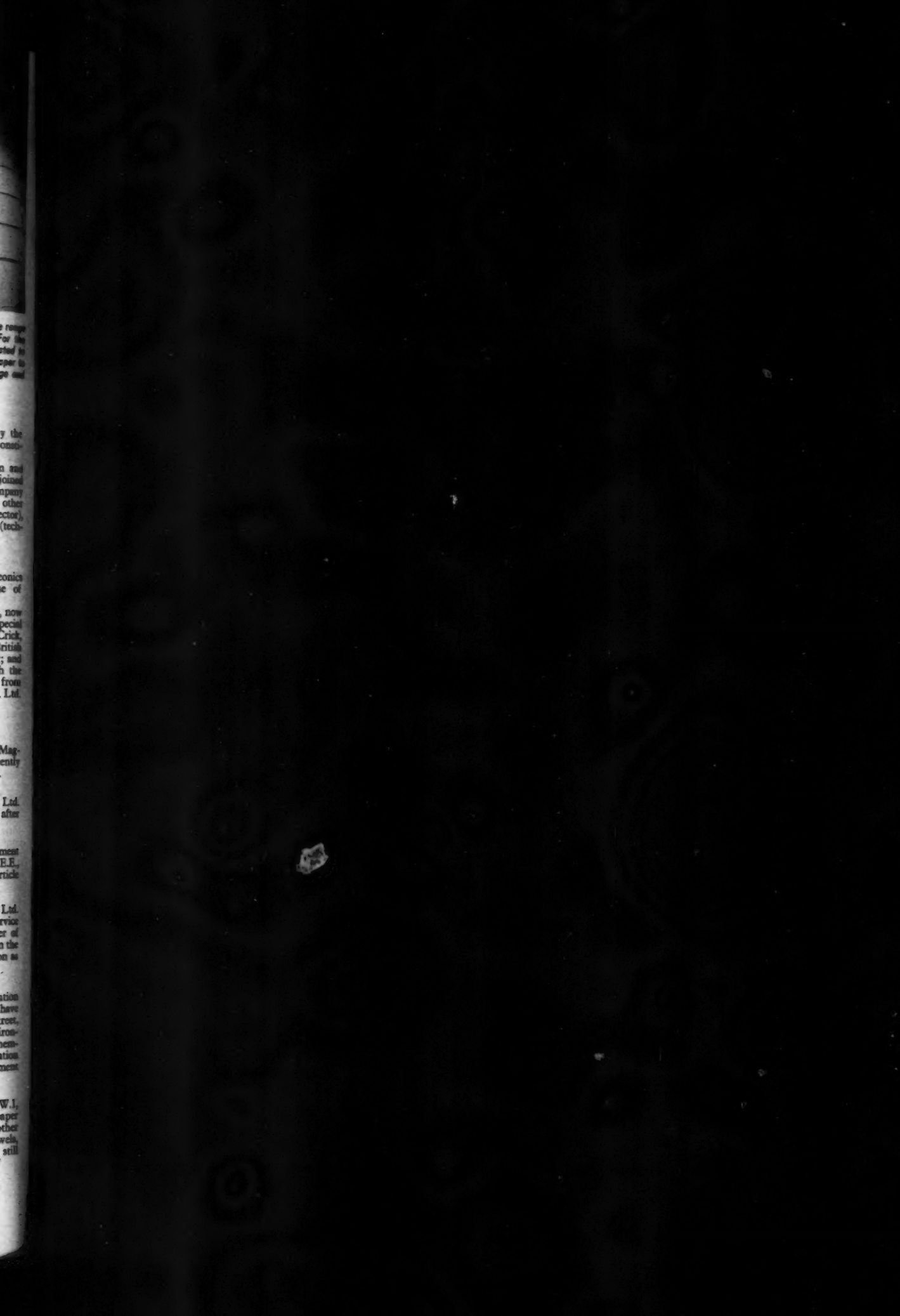
R. B. Pullin & Co. Ltd. report that their chief development engineer, Mr. E. Lloyd Thomas, B.Sc., A.C.G.I., M.I.E.E., F.R.Ae.S., has been awarded an R.I.C. premium for his article *Analogue Computation*.

* * *

Two new appointments have been announced by Canadair Ltd. Mr. Albert W. Yates, who was previously manager of the service department of Fairchild Engine Division, becomes manager of military aircraft sales; and Mr. D. W. H. Godfrey, formerly on the staff of *The Aeroplane*, has joined the public relations division as assistant manager of information services.

* * *

Vibration test laboratories, manned by experienced vibration test engineers and backed by the company's main laboratory, have been opened by W. Bryan Savage Ltd., of 17 Stratton Street, London, W.1. They are equipped to accept vibration/environmental work which customers are unable to carry out for themselves owing to heavy commitments of their own vibration equipment, or through not having the necessary equipment available.

* * *

Kimberly-Clark Ltd., 11 Grosvenor Gardens, London, S.W.1, have announced the introduction of a new white Hi-Dri paper towel, known as Hi-Dri Super, for use in factory, office and other washrooms. Available in both roll form and as individual towels, it is said to have "an abnormally fast absorbing rate" while still containing "the same high degree of wet strength as hitherto."